RUBBER CULTIVATION

In the British Empire.

A Lecture delivered before

THE SOCIETY OF ARTS

BY

HERBERT WRIGHT, A.R.C.L., F.L.S.

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THE SOCIETY OF ARTS

BY

HERBERT WRIGHT, Ass. R.C.S., F.L.S.,

(Late Controller of the Government Experiment Station, Ceylon, and
author of "Hevea brasiliensis: its Botany, Cultivation,
Chemistry and Diseases.")

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Lecture.

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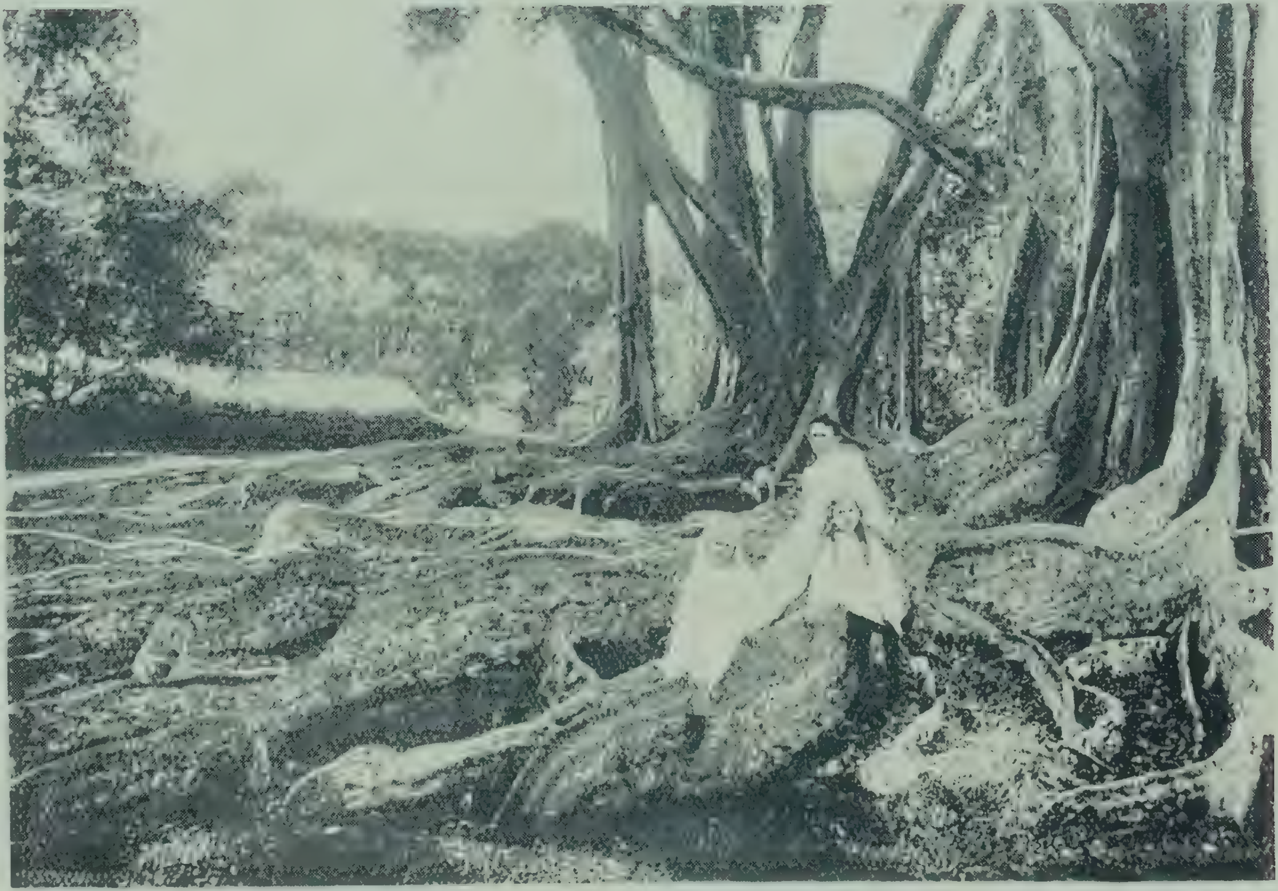

Photo by H. F. Macmillan

Old Ficus elastica trees in Ceylon

GOVT. BOTANIC GARDENS, LAL BAGH BANGALORE.

RUBBER CULTIVATION.

(WITH SPECIAL REFERENCE TO PARTS OF THE BRITISH EMPIRE).

By Herbert Wright.

THE cultivation of rubber-yielding plants has been brought prominently before the public during the last few years, and has aroused considerable interest. At the present time almost every institution concerned with tropical products is directing its attention to rubber-yielding plants, and recent developments in Ceylon, Southern India, Malaya, and other parts of the world, appear to have presented an opportunity of an unparalleled type to the investing public. It is necessary to consider the potentialities of this tropical industry and to determine its present and future importance from the producer's standpoint, especially in British possessions.

Development of the Rubber Market.

The stimulus which has been given to the exploitation of wild rubber and the establishment of plantations is evident from a consideration of the figures showing the consumption and value of rubber during the last few years; the increase in value from about three to over five shillings per lb. has been encouraging to rubber planters, and the increase in consumption, as shown in the figures kindly furnished by Messrs. Hecht, Levis, and Kahn, has inspired confidence in all concerned. Furthermore, the developments in the past few years on Eastern plantations have shown that yields are obtainable which were once considered impossible, while the expenditure incurred in collecting and preparing the rubber is rapidly being brought near the minimum :—

Year.	World's consumption of rubber.	Range in value of fine Para, per lb.					Prices paid for some samples of plantation rubber.	
	Tons.	s.	d.		s.	d.	s.	d.
July, 1899, to June, 1900	48,352	3	8½	to	4	9½	4	0
July, 1900, to June, 1901	51,136	3	6	to	4	4½	4	1½
July, 1901, to June, 1902	51,170	2	11¼	to	3	11½	4	0
July, 1902, to June, 1903	55,276	2	10¼	to	4	1½	5	0
July, 1903, to June, 1904	59,666	3	9	to	4	11	6	0
July, 1904, to June, 1905	65,083	4	5	to	5	9	6	8
July, 1905, to June, 1906	62,574	5	0¾	to	5	8	6	3

Rubber, Gutta, and Balata.

The relative importance of the india-rubber, balata, and gutta-percha industries is indicated in the following figures* :—

---

* Atlas of the World's Commerce, Part 7, 1906.

ANNUAL EXPORTS OF INDIA-RUBBER, GUTTA-PERCHA, AND BALATA. AVERAGE FOR YEARS 1901, 1902, 1903.

TOTALS.

Rubber	973,000 cwt.	£12,537,000
Balata	50,000 ,,	£387,000
Gutta	220,000 ,,	£2,014,000
	1,243,000	£14,938,000

The gradually increasing demand for raw rubber, the remunerative prices at present paid for it, and its relative importance among the products of the tropical world, are all that we can reasonably desire, and under these circumstances we may naturally expect to see a fair amount of capital invested in many islands and territories in the tropical zone. It will be shown later how the "wild" rubber has been practically the only source in the past; the promising importance of plantation and semi-wild rubber has apparently, as far as many English capitalists are concerned, been more attractive, and a statement of the sums invested in notable properties will best serve our purpose.

PAID-UP CAPITAL OF RUBBER-PLANTING COMPANIES.

	£
Malay	2,048,281
Ceylon and India	415,213
Islands in Indo-Malayan region	651,123
America	765,000
Africa	430,000
Sterling equivalent of capital existing in Rupee and other local currency in:—	
Malay	532,748

Ceylon and India	370,566
Islands in Indo-Malayan region	28,333
Companies growing rubber in conjunction with tea, cacao, and other products	9,121,761
Grand total	£14,363,325

These figures, kindly furnished in March, 1907, at my request by Mr. Fritz Zorn, show about five-and-a-quarter million sterling invested in rubber alone, an amount which is being daily increased, and one which, if viewed in the light of the premiums at present obtainable for many of the shares, is considerably higher than the sum quoted here. It should also be remembered that only the paid-up capital is here dealt with, and that since the figures were compiled, other companies have been successfully floated in England and Ceylon.

You will observe that, in the foregoing table, only those companies registered in Great Britain, Ceylon, India, and Malaya have been taken into account. English capital has also been invested in the cultivation and exploitation of rubber in numerous East and West Indian islands, in tropical America and Africa, and very large sums from Continental areas have been supplied for the same purpose. These have been entirely omitted in the figures given in this part of the paper.

As most of you are aware the shares of many concerns, now prominently before the public, are standing at very high premiums, representing, in many cases, from three to eight times the paid-up capital; there are numerous semi-public and private properties in the Indo-Malayan region, about which little can be at present divulged; numerous cacao, tea, and coffee estates are gradually but surely being supplanted by rubber-producing species; large areas are being daily alienated for rubber; forests, with indigenous rubber plants, are being exploited under scientific guidance; and much interest is being display in this seemingly profitable cultivation. But neglecting all these side developments, it may be safely stated that to-day there are no less than fourteen million pounds of English money represented as paid-up capital, in companies directly or indirectly concerned with rubber-growing, and registered in England and our East Indian possessions. Furthermore, it may be estimated that approximately £30,000,000 worth of rubber may be consumed during the present year. These facts, though indicating that large sums of money have been vested in the production and utilisation of rubber, are insignificant compared with developments which are at the present time in an embryonic stage. Nevertheless, they show that the cultivation and exploitation of rubber plants have to be taken seriously, and, barring unforeseen developments, we may expect the final result to be such that British possessions in the tropics will be placed in the front rank as producers of plantation rubber.

Sources of Rubber.

Having seen that the consumption of rubber is on a sufficiently large scale to lead to the investment of several million sterling in its exploitation, it now becomes necessary to deal briefly with the sources of production. The most striking feature is the almost absolute dependence to-day of the manufacturers on the rubber obtained from trees indigenous to certain tropical forests and their independence of the plantation product. It is necessary to point out that tropical America is the most important centre for rubber collection (about 60 per cent.), tropical Africa the next (30 to 35 per cent.), and tropical Asia, the least important, since it only contributed, last year, a very small proportion (about 3 per cent.), made up of wild and plantation material. It is of interest to recapitulate that the richest wild rubber areas in tropical America (Brazil, Venezuela, Bolivia, Peru, Central America, and Mexico), and in tropical Africa (Congo Free State) are not British, though capital from this country has been recently diverted to parts of these two vast continents for the exploitation of rubber.

Tropical America.—In tropical America the only British possessions of much importance are British Honduras and British Guiana. British Honduras is a colony on the east coast of Central America, having 90 square miles out of a total of 7,562 square miles under cultivation. *Castilloa elastica* is described as occurring near the rivers Belize, Sibun, and Mullins. The colony produces very little rubber at the present time, and that only from wild trees near the coast; the available statistics* show a gradual decline in the export of this produce:—

EXPORT OF RUBBER.

Year.	Weight in lb	Value in dollars
1901	40,044	23,237
1902	30,338	14,163
1903	22,176	13,002
1904	28,042	18,262
1905	22,926	15,921

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* Colonial Report, No. 515, British Honduras, 1905.

The Statistical Abstract* shows only 20,111 lb. exported, valued at £2,815, for British Honduras in 1905.

British Guiana, which is a portion of the South American Continent, though bounded on the east, south, and west by Dutch Guiana, Brazil, and Venezuela respectively, is not so much noted for its rubber export as for its "Balata," and under the heading of "Rubber Production" for that country, the Statistical Abstract for 1906 gives the following, without distinguishing the small quantity of rubber from the large quantity of balata :—

Year.	1895.	1900.	1905.
Quantity in lb.	159,524	425,571	497,829
Value in Sterling	£8,923	£19,585	£41,487

Tropical Africa.—In tropical Africa—though British possessions concerned in exporting or collecting rubber do not compare very favourably with the Congo Free State and other areas—there are indications of widespread activity from the most northerly districts of the West Coast to Natal in the south-east of that Continent. The following figures show the changes during recent years in British rubber-producing areas in Africa :—

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* Statistical Abstract for the several British Colonies, Possessions, and Protectorates, 43rd No., 1906.

Country.	Quantity in lb.			Value in Sterling.		
	1895.	1900.	1905.	1895.	1900.	1905.
British Central Africa Protectorate ...	563	86,404	17,280	28	9,332	2,160
Uganda Protectorate	—	—	101,164	—	—	13,305
British East Africa Protectorate ...	104,850	100,600	144,032	8,192	10,060	18,929
Protectorate of Southern Nigeria ...	308,309	2,251,315	2,842,831	11,787	137,289	226,387
Colony of Southern Nigeria (Lagos)...	5,069,577	596,332	274,144	269,893	48,239	23,791
Gold Coast	4,022,385	3,452,440	3,687,778	322,070	328,156	323,774
Sierra Leone	1,429,680	274,624	426,610	86,940	25,741	49,132
Gambia	—	—	9,071	—	—	915

In British Central Africa the cultivators are encouraged to plant rubber vines and trees; there is no export duty on cultivated rubber*, but one of 4d. per lb. is levied on all rubber from wild plants. There are, at present, about 850 acres cultivated with *Ceara*, *Landolphia*, *Castilloa*, and other rubber-yielding species, the large cultivated properties being in the Blantyre and Zomba districts. It is stated† that very little rubber is now obtained from the Protectorate itself, and the following details are given in the Colonial Report for 1905-6:—

Year.	Crop exported to 31st March of each year (lb.)	Valued at £
1898	21,416	1,059
1900	118,720	13,356
1902	14,393	1,619
1904	4,262	426
1906	17,283	2,160

In the Uganda Protectorate there has been a renewal of interest and activity in the collecting of rubber from wild trees owing to the discovery of large numbers of valuable trees and vines in local forests. In the Mabira Forest, Uganda, Dr. Cuthbert Christy estimates that in an area of about 54 square miles there are approximately 1,760,000 rubber trees, and the value of this and other important statements will be discussed shortly.

In British East Africa, under whose administration all the Uganda provinces east of Lake Victoria were placed in 1902, large areas of land have been leased to rubber collectors, chiefly Indian and Arabian, and numerous experiments are now being made with indigenous and introduced rubber-yielding species, near Mombasa. According to one authority, the chief rubber areas* are (1) Coast strip, running from 5 to 20 miles inland; (2) Kitui area; (3) Laitokitok; (4) Ravine; (5) Kamasia; (6) Nandi; and (7) Lumbwa. The same authority states that there is a 10 per cent. export duty on rubber, and that the amount exported during 1905 was valued at approximately £15,000.

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* Colonial Report, No. 499, B.C.A., 1905-6.

† "Bull. Imp. Inst.," London, Vol. IV., No. 4, 1906.

In Northern Nigeria small areas are now being planted with rubber, and recommendations have been put forward advising that large plantations containing the best kinds of rubber plants should be established without delay. In the year 1905-06 rubber formed nearly three-fourths or 68 per cent. of the total value of the exports, but regret has been expressed at the destruction of rubber vines occasioned by the methods of collecting commonly practised. According to the latest report† "an Ordinance has been evolved, the principle of which is to hold the purchaser responsible that no *root* rubber is bought or exported. It, however, appears difficult to distinguish between rubber prepared from the root and that from the stem, and it is now under consideration whether the latter should not also be prohibited."

The large export of rubber from Lagos in 1895 has been attributed to the introduction of natives experienced in tapping, from the Gold Coast. There has, however, been a decline in the exports during recent years from the Gold Coast itself, and it is hoped that this will soon be remedied. The export of rubber from Sierra Leone in 1905 was equal to 11.27 per cent. of the total exports for that country, and was exceeded, in proportionate value, only by palm kernels and cola nuts. According to the Statistical Abstract, 1906, "in Sierra Leone an

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* Leaflet No. 14, Nairobi, Dept. of Agr., B.E.A.

† Colonial Report, No. 516, Northern Nigeria, 1905-06.

Ordinance has passed the Legislative Council which provides for the prohibition of the exportaton of root rubber from January 1st, 1907." Gambia shows in its export during 1905 a considerable fall, the previous year being responsible for 30,934 lb. of rubber valued at £2,446.

In North-Eastern Rhodesia, in Natal, and in the Soudan, rubber is still of considerable interest. In Natal, probably the most southernly point for rubber production in Africa, the Government some time back offered to lease the rights of rubber-collecting over immense areas for a period of five years. The Soudan was once largely indebted to the rubber industry as a source of revenue, but bad methods of collecting have evidently been adopted with disastrous results; a concession for extracting rubber in Abyssinia has been granted by Emperor Menelik.

Sufficient has been said to show that rubber vines and trees are distributed throughout many parts of Africa and America. The relative insignificance of our exports from British possessions in the West Indies and the Indo-Malayan regions is obvious from the following:

West Indies.—In the West Indian islands the cultivation of rubber-producing plants is not in a very advanced state. There is only one indigenous climbing plant of note, and the main experiments appear to have been with trees of *Castilloa elastica* and rubber trees as shade in association with cacao trees. In 1902 Jamaica exported about 230 lb. of rubber; in 1903 Bahamas exported 84 lb.; Trinidad and Tobago exported in 1905, 9,394 lb., valued at over £1,200. At the present time many experiments are being made with tropical American and African species in Trinidad, Tobago, Dominica, Jamaica, and St. Lucia; the results will be detailed elsewhere.

Eastern Countries.—The Indo-Malayan region, which includes Southern India, Ceylon, Burma, Malaya, New Guinea, Borneo, &c., is at the present time one of great activity, and, though the past exports have not been by any means very large, much is expected from this area in the near future. There are several indigenous species of known value, but the future developments probably lie mainly in the cultivation of species from tropical America. The figures of export given below indicate the present insignificant position of our Eastern possessions as producers of rubber.

India.—In the year 1905-06 the export* showed a further advance on that for 1904-05 by 40.6 per cent., and attained a total value of Rs. 12.82 lakhs; this refers mainly to wild rubber.

	1900-01.	1901-02.	1902-03.	1903-04.	1904-05.
	cwt.	cwt.	cwt.	cwt.	cwt.
Bengal	3,289	2,223	700	1,226	2,349
Burma	4,409	1,913	335	566	1,871
Total Export ..	7,698	4,136	1,035	1,792	4,220
Value in Sterling	£103,189	£40,280	£9,410	£23,146	£60,784

Ceylon and Malay States.—The following are the exports of plantation india-rubber from Ceylon and the Malay States for the last two years:—

	Ceylon.	Malay States.	Total.
1905	... 70 tons	... 75 tons	... 145 tons
1906	... 160 ,,	... 350 ,,	... 510 tons

The export from Ceylon during 1906 does not represent that island's present producing capacity; about 80,000 lb. were re-exported from the Straits, and about 9,500 lb. from China.

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* India Office Records, London, 1906.

Ceylon.—The following figures show the development in Ceylon exports of plantation rubber :—

Year.	Approximate Quantity Exported.
1900	73 cwt.
1901	66 ,,
1902	189 ,,
1903	389 ,,
1904	676 ,,
1905	1,401 ,,
1906	3,200 ,,

New Guinea, Borneo, &c.—British New Guinea, in 1902, exported 12,983 lb. of rubber, valued at £1,435. During 1905 the collection of rubber was prohibited for the greater part of the year, and the total export was only 590 lb., valued at £67. The rubber is obtained from indigenous species, but in 1905 and 1906 Ceylon sent a large number of other species to the authorities in New Guinea.

Borneo has long been known for the export of rubber obtained from indigenous species. Numerous estates have already been taken in hand in consequence of results obtained with tropical American plants. The planted acreage is rather small, but mature trees of *Hevea brasiliensis* are already known in that island.

The Seychelles, Fiji, New Caledonia, and other islands in the East, are also developing a strong interest in rubber-producing plants; as countries of export they may be largely neglected in this paper.

Botanical Sources of Caoutchouc.

The fact that out of a total rubber export of about 65,000 tons for 1906, no less than about 38,000 tons came from tropical America, and about 17,500 from tropical Africa, compels us to look to these two great continents for the majority of the caoutchouc-yielding plants, and to place the whole Asiatic or Indo-Mâlayan region in a minor or third position of importance. Our first duty is to see which plants provide the caoutchouc in each area, and to trace the distribution of notable species from one country to another.

The natural order which has furnished, and which still supplies the greater part of the world's rubber, is the *Euphorbiaceæ;* the valuable species of *Hevea*, *Manihot*, *Sapium*, *Micrandra*, and *Euphorbia* which it comprises, are indigenous mainly to the tropical American region, but have been distributed to all parts of the tropical world. Next in importance, perhaps, is the *Apocynaceæ*, remarkable in tropical Africa for the valuable rubber species of *Landolphia*, *Funtumia*, *Clitandra*, *Mascarenhasia*, *Carpodinus*, &c.; this order also comprises the genera *Chonemorpha*, *Xylinabaria*, *Tabernæmontana*, *Melodinus*, *Alstonia*, *Hancornia*, *Urceola*, *Willughbeia*, *Hymenelopus*, *Parameria*, *Diplorhynchus*, *Forsteronia*, *Leuconotis*, *Ecdysanthera*, and *Micrechites* known in many parts of the tropics for the quality of rubber they yield.

The *Urticaceæ* is also of importance in tropical America for the species of *Castilloa*, and for the genera *Ficus* and *Artocarpus* in parts of Africa and the Indo-Malayan region.

The *Asclepiadaceæ*, though it possesses such a large number of laticiferous species abundantly distributed, especially in tropical Africa, is remarkable for the absence of good caoutchouc-yielding plants; true, the genus *Cryptostegia* in Madagascar and India furnishes us with a small quantity of caoutchouc, but the other important genera, such as *Calotropis*, *Cryptolepis*, *Marsdenia*, and *Cyanchum*, have not yet been found to yield latices of high commercial value.

Perhaps the most remarkable natural order in this respect is the *Compositæ;* though it is represented by such a large number of species and is to be observed in almost every part of the world, there are hardly any species of value to the cultivator of caoutchouc plants; during the last few years, however, there is one member of this group—*Parthenium argentatum*, A. Gray—which has come to be regarded as the source of Guayule rubber in Mexico, and another—a species of Hymenoxys—as the source of Colorado rubber. *Sonchus oleraceus, L.*, has also been mentioned by Jumelle as yielding caoutchouc of value.

Another natural order of note in this respect is the *Lobeliaceæ*, since the tropical American species of *Siphocampylus*, found in Columbia and Ecuador, have been said to yield caoutchouc of commercial value.

Distribution of Important Caoutchouc Plants.

The geographical distribution of the more important caoutchouc-yielding plants is imperfectly known, but a general idea of the plant areas where certain species thrive can be given. Rubber-producing plants occur in both hemispheres, and are confined to approximately 25 degs. or 28 degs. north and south of the Equator. In this area the three most important regions are, following the floral regions of the world as divided by Drude: (1) the tropical American; (2) the tropical African, including Madagascar; and (3) the Indo-Malayan region. These three regions supply nearly the whole of the rubber of commerce.

Indigenous and Introduced Plants.—It may also be said that, of the three areas enumerated, the tropical American and African are, at present, only concerned with the extraction of latex and cultivation of plants which are indigenous to those areas—*Hevea*, *Manihot*, *Funtumia*, *Landolphia*, &c.—whereas the Indo-Malayan region, though it possesses a few indigenous species of value, such as *Ficus elastica*, *Cryptostegia grandiflora*, and others, is directing its attention almost exclusively to-day to the cultivation of species introduced from the tropical American region, and to a few from the African zone. The tropical American region has been the home of the plants which have led to the rubber industry in Ceylon, Straits Settlements, Federated Malay States, and Southern India, and has supplied even tropical Africa with species which rank as of first importance at the present time.

Trees, Shrubs, and Climbers.—Another interesting feature of the laticiferous flora of these three vast regions, is the nature of the plants predominating in each area. It may be said that the caoutchouc plants of the tropical American area, are mainly of an arborescent type, *e.g.*, *Hevea brasiliensis*, *Castilloa elastica*, *Manihot Glaziovii*, and *Sapium;* a few shrubby plants, such as *Parthenium argentatum*, and climbers such as *Forsteronia floribunda*, do of course, exist there.

On the other hand, the rubber industry of the African region, especially if we include Madagascar, is principally concerned with climbers or lianes — *Landolphia*, *Clitandra*, *Carpodinus*, *Cryptostegia*, &c.; indigenous tree forms, such as *Funtumia elastica*, *Ficus Vogelii*, and introduced tree forms also abound in certain areas of Africa. In the Indo-Malayan region, on the other hand, there is a very mixed indigenous type, composed of huge tree forms such as *Ficus elastica* and *Sapium insigne*, and climbers, such as species of *Willughbeia*, *Cryptostegia*, *Urceola*, *Leuconotis*, *Parameria*, &c.

The introduced plants cultivated in the Indo-Malayan region are nearly all of the arborescent type—such as *Hevea*, *Manihot*, *Castilloa*, *Sapium*, *Funtumia*, &c., with a few lianes, the most prominent of which is *Landolphia*. The Table given below will show the present position of introduced and native plants now largely exploited for rubber in the three areas :—

IMPORTANT CAOUTCHOUC PLANTS.

(Generic Names.)

Tropical America (including the West Indies) :—
  Native.—Hevea, Castilloa, Manihot, Sapium, Hancornia, Micrandra, Parthenium, Hymenoxys, Brosimum, Forsteronia.
  Introduced.—Funtumia, Landolphia, Castilloa, Hevea, Manihot.
Tropical Africa :—
  Native.—Landolphia, Funtumia, Ficus, Carpodinus, Clitandra, Cryptostegia.
  Introduced.—Hevea, Manihot, Castilloa, Cryptostegia, Ficus.
Indo-Malay :—
  Native.—Ficus, Willughbeia, Urceola, Parameria, Cryptostegia, Chonemorpha, Ecdysanthera, Leuconotis, Rhynchodia.
  Introduced.—Hevea, Manihot, Castilloa, Landolphia.

Rubber Species.

Most companies who have gone in largely for rubber cultivation have selected trees for planting purposes, which have become known in virtue of their caoutchouc-yielding capacities. There is, however, an extraordinary degree of laxity displayed by a few individuals who simply apply for, or say they have planted, *Hevea, Castilloa, Manihot, Ficus*, &c. It is as well to state that in each of these genera, as in many others, there are numerous species known to yield caoutchouc, but in very variable quantities and of different qualities. Undoubtedly, in tropical America and Africa, the latices of numerous species frequently contribute to the rubber exported in a form known under one name, and the real rubber values of many species of *Hevea, Sapium, Landolphia*, and *Manihot*, are but little known, except to the natives on the spot. There are some companies operating in tropical America who find it to their interest to cultivate a species of *Manihot*, other than *M. Glaziovii*, Muell. Arg., though the latter is the species which has been distributed to the East, and which everyone has hitherto associated with Ceara rubber for many years. During a very brief study at Kew, the importance of correctly identifying the caoutchouc species in wild areas for subsequent developments has strongly impressed me.

We will consider a few of the more important genera previously mentioned.

Hevea.—The genus *Hevea* furnishes the largest quantity, and perhaps the best quality, of rubber in the world. It is represented by *Hevea brasiliensis*, Muell. Arg., and *H. similis*, Hemsl., in Brazil, Eastern Peru, and Bolivia; by *H. spruceana*, Muell. Arg., *H. minor*, Hemsl., *H. benthamiana*, Muell. Arg., *H. rigidifolia*, Muell. Arg., and *H. discolor* in North Brazil; by *H. pauciflora*, Muell. Arg., in North Brazil and British Guiana; by *H. lutea*, Muell. Arg., in North Brazil and East Peru; by *H. confusa* in British Guiana, and by *H. guian-*

ensis, Aub.* In the basin of the Amazon and in the south of Venezuela and the Guianas, species of Hevea are abundant and scattered among other forest types; further north they are replaced by *Castilloa* and *Parthenium*, and on the Atlantic side by *Manihot* and *Hancornia*. The map which I am able to show to-night by favour of John Bartholomew and Co., will indicate the distribution of the rubber-producing areas in the basin of the Amazon.

Among the species of *Hevea* enumerated above there are several which yield large quantities of latex, but *Hevea brasiliensis* is probably responsible for the greater part of the Para rubber of commerce. *H. benthamiana* has been confused with *H. brasiliensis*, and is said to be cultivated, at the present time, in some parts of Venezuela.

Sapium.—The genus *Sapium*† has been variously dealt with, and much confusion exists to-day regarding the botanical identity of the species which are of value as sources of caoutchouc. *Sapium mexicanum*, Hemsl., and *S. laterifolium*, Hemsl., native to Mexico, may be classed as doubtful sources of caoutchouc, though the juice of the latter hardens into a kind of india-rubber. In British Guiana, *S. Jenmani*, Hemsl., is known locally as Toukpong; *S. paucinervium*, Hemsl., is said to yield abundance of latex of a kind; and *S. aucuparium*, Jacq., is considered to be of doubtful value. In South America many other species occur, but do not appear to be of much commercial worth. The species known as *S. verum*, Hemsl., which occurs in Columbia and Western Ecuador has, according to Hemsley, been confused with *S. biglandulosum*, once regarded as a polymorphic form, and the so-called source of "Columbia Virgen"; that occurring in Western Ecuador has been described by Dr. Preuss as being a good rubber tree. In North Brazil, *S. ciliatum*, Hemsl., is said to form a small tree from 12 to 15 feet high, and to yield india-rubber. Another species* occurring in Venezuela, Columbia, and Ecuador, and known as *S. stylare*, Muell. Arg., is said to yield its greatest quantities of rubber at an elevation of 5,000 feet, where the mean temperature is between 57 and 61° F. In Columbia and Ecuador the *Sapium* species are intermingled with those of *Castilloa*, and are considered to be the source of the white rubber "Caucho blanco"; in other parts of South America the trees are intermingled with *Hevea* species, and the latex of both are mixed together in the preparation of certain grades of rubber.

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* "Icon. Plantarum," xxv., Series 4, 6, 1899.

† "Icon. Plant," Hooker, xxvii., Ser. 4, 7, 1901.

Castilloa.—Castilloa is a genus represented by certain valuable species in tropical America. As in the case of *Sapium* the synonymy is a trifle confused, and will become more so if the representations of Cook† and Seffer‡ are seriously considered. There are three species recognised at the present time, and other names have been given to forms which probably present certain minor differences when compared with the true *Castilloa elastica*, Cerv. *Castilloa elastica*, Cerv., *C. Tunu*, Hemsl., and *C. australis*, Hemsl., are the three recognised species in tropical America. *C. Tunu* was once confused, at Kew, with *C. elastica;* the name *C. markhamiana* has been applied to two plants, one of which (*C. markhamiana*, Markham), turned out to be the ordinary *C. elastica*, Cerv., and the other

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* "Icon. Plantarum," Series 4, 8, 1905.

† Cook.

‡ Rubber planting in Mexico and Central America, Agr. Bull. of Straits and F.M.S., Jan., 1907.

Photo by H. F. Macmillan.

Young Castilloa elastica trees in Ceylon.

(*C. markhamiana*, Col.) to be *Perebea markhamiana*, Hemsl. Cook and Seffer have suggested and used the name *C. lactiflua* for one form; others speak of varieties, rubra, alba, nigra, nicaraguensis, and so forth.

It should be clearly pointed out that *C. elastica*, Cerv., occurs in Mexico, Honduras, Guatemala, Salvador, Nicaragua, Costa Rica, Columbia, and Ecuador, and in this range of latitude of about 37° may be expected to show some variation according to habitat. *Castilloa elastica* is probably distributed over a wider range of latitude than any other rubber-producing plant, occurring, as it does, from Mexico to parts of Southern Brazil. It has been known to science longer than most other caoutchouc plants, having been first described by Cervantes* at a meeting of the Royal Botanic Garden of Mexico in July, 1794. In many parts of Mexico and Central America it is the only rubber plant exploited, but in other areas is the predominant type, and occurs mixed with species of *Sapium*. Its presence has not been confirmed in the Guianas and Venezuela†. It yields an excellent rubber. *Castilloa Tunu* occurs frequently in the forests of British Honduras and Costa Rica. It has been described as yielding rubber in abundance and of good quality. *Castilloa australis* has a limited distribution, and, though it often occurs in the Peruvian forests, has not been described as a good species for caoutchouc. Hemsley states‡ that it possesses a clammy, milky juice.

Manihot.—The genus *Manihot* contains one species—*Manihot Glaziovii*, Muell. Arg.—which yields Ceara or Maniçoba rubber. It occurs wild in the forests of Brazil*, and its produce is shipped from the ports of Ceara, Bahia, and Pernambuco. It has been distributed to Africa, Mauritius, Madras, Burma, Ceylon, Straits Settlements, Seychelles, Zanzibar, Jamaica, Dominica, &c.

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* "The World's Commercial Products," Parts 9 and 10, 1906.

† Jumelle, "Les Plantes a Caoutchouc et a Gutta," 1903.

‡ "Icon. Plantarum," xxvii., Series 4, 7, 1901.

The wild trees of this species are not distributed over as large an area as are those of *Hevea*. The Brazilian forests containing large numbers of *Manihot* trees are mainly between 3 to 10 degrees from the equator, the eastern corner of Brazil, including the States of Ceara, Pernambuco, Piauhy, Maranhao, and Rio Grande do Norte, being of especial interest. Trees of *Manihot Glaziovii* occur at Para, and to the north-west this species is replaced by those of *Hevea*. In some parts of Brazil two plants are confused with this species; one is known as "Maniçoba"—the true form—and another, "La fraca," which is probably a variety of the same species, is described as being capable of yielding good caoutchouc.

There appears to be a species of *Manihot* differing widely from *M. Glaziovii*, which is now being cultivated in parts of tropical America; perhaps our Chairman can give us some information regardng an interesting species of *Manihot*, seedlings of which, I understand, are being reared at Kew.

Parthenium, or Guayule Rubber.—The name "Guayule" is given to the rubber obtained from *Parthenium argentatum*, A. Gray. This species is a *Compositæ;* it is a small plant varying from 8 to 40 inches in height, and has a much branched stem. According to Endlich, it occurs over a large portion of the bush prairies in Northern Mexico, and also extends into the United States, and is met with in Texas, New Mexico, and Arizona. Its occurrence has been reported but not confirmed in

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* Martius' Flora Brasiliensis, XI., Part II., p. 443.

Southern Mexico, Central America, and Venezuela. It has been stated that the area in Northern Mexico, over which this plant is distributed, is about 29,000 square miles; it occurs from 3,000 to 5,600 feet above sea-level as well as upon the plateaux.

Hancornia.—Hancornia speciosa, Muell. Arg., is the name of the tree which yields the Mangabeira or Mangaba rubber of Brazil. It is widely distributed throughout Brazil, but is not regarded as being of exceptional value in Pernambuco, Bahia, Matto Grosso, or Sao Paulo. It has been reported in Bolivia and Eastern Peru. The tree attains a height of 13, 16, and 23 feet, is well supplied with branches and grows well in dry districts at an elevation of 500 to 600 feet above sea-level.

Forsteronia.—This genus possesses two species, both lianes and natives of tropical America, which furnish useful rubber; they are found in Jamaica, and between Mexico and the South of Brazil. *Forsteronia gracilis*, Muell. Arg., occurs abundantly in British Guiana, where it is known, according to Jenman, by the name of "Macwarrieballi," and is said to yield rubber of good quality. *Forsteronia floribunda*, DC., appears to be found only in Jamaica, where it is known locally as the milk-wythe or milk-vine. It occurs as a climbing shrub in the forests in the interior of Jamaica, and yields a caoutchouc of value.

Hymenoxys or Colorado Rubber.—A species of *Hymenoxys**, Cass., has been reported to occur "abundantly in the hills and mesas in the vicinity of Salida, the belt extending into the San Luis Valley, Gunniston County, and as far south as New Mexico." This plant is the source of what has been termed "Colorado" rubber, the roots often yielding as much as 10 per cent. of rubber of a somewhat inferior quality.

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* Kew Bulletin, l.c.

Micrandra, Brosimum, &c.—Before leaving the chief American rubber-yielding species, reference may be made to *Micrandra, Brosimum,* and *Siphocampylus.* The genus, *Micrandra,* is placed in the *Euphorbiaceæ;* two species are known which occur wild in Central Brazil, and are said to form part of the Amazon rubber. *Brosimum galachodendron,* the cow tree or "Palo de Vaca," is a large tree which occurs in South America and yields a resinous rubber. *Siphocampylus caoutchouc,* Don, grows wild in Columbia, *S. Jameaonianus,* DC., in Ecuador, and *S. giganteus,* Don, in tropical America; all three are said to yield rubber of value.

African Rubber Plants.

Numerous plants are known in tropical Africa and Madagascar, but among the more notable genera we need only include for our present purposes, *Landolphia, Clitandra, Carpodinus, Funtumia, Mascarenhasia, Pleiocarpa, Rauwolfia, Ficus,* and *Cryptostegia.*

Landolphia.—The genus *Landolphia* has supplied a great part of the rubber from Africa, and large numbers of these climbing plants have been destroyed by native collectors of rubber. There are about forty species known in this genus, many of which supply large quantities of good caoutchouc; other species yield resinous latices and many an abundance of rubber from their roots. Several species have in the past been referred to the genus *Clitandra,* and some confusion exists with regard to the nature of their latices as well as their botanical identity. Among the species said

Photo by H. F. MACMILLAN.

Young vines of Landolphia Watsoniana.

to yield good rubber are *L. Heudelottii* A.DC., *L Kirkii*, Dyer, *L. Dawei*, Stapf, *L. owariensis*, Beauv. ; several species have been reported as yielding rubber of uncertain value or in doubtful quantities among which may be mentioned *L. kilimandjarica*, Stapf, *L. Buchananii*, Stapf, *L. Stolzii*, Busse, *L. droogmansiana*, De Wild., *L. Klainei*, Pierre, *L. reticulata*, Hallier, *L. petersiana*, Dyer, *L. Pierrei*, Hua, *L. lucida*, var. hispida, Hall. One of the most notable species said to yield root rubber is *L. Thollonii*, Demierve; it occurs abundantly in the French and Lower Congo and Angola. Much money and time have been wasted in connection with certain species; those which may be described as worthless for rubber purposes include *L. florida*, Benth., abundantly distributed in parts of Sierra Leone, Gold Coast, Lagos, British East Africa, &c., and also *L. ugandensis*, Stapf, and *L. subturbinata*, Stapf. These plants, though they are not the most suitable for cultivation, are of much importance at the present time.

Clitandra and Cryptostegia.—These genera furnish a small quantity of root and stem rubber. The important species of *Clitandra* appear to be abundant in the Congo, Liberia, Uganda, &c. *C. henriquesiana*, K. Schum., is an erect shrub, said to yield root rubber; *C. orientalis*, K. Schum., which occurs frequently in the Congo Free State, and has recently been found by Dawe, at an elevation of 4,000 feet in Uganda, is a vine furnishing an excellent rubber; *C. Nzunde*, De Wild., *C. flavidiflora*, Hallier, *C. nitida*, Stapf, and *C. cirrhosa*, Radlk., are also described by some authorities as yielding rubber in Africa.

The genus *Cryptostegia*, to which we shall refer in another section, also furnishes species of value as rubber-yielding plants.

Carpodinus.—The value of most of the African species of this genus has often been discussed; many contradictory statements have been made regarding the value of the root rubber from *C. lanceolatus*, K. Schum.; and *C. hirsuta*, Hua et Chev., *C. uniflora*, Stapf, *C. dulcis*, Sab., *Barteri*, Stapf, *C. acida*, Sabine, *C. oocarpa*, Stapf, *C. leucantha*, K. Schum., have been variously described as yielding rubber of good, variable, and questionable value.

African Rubber Trees.

Among the indigenous tree forms which are of value to rubber collectors those belonging to the genera *Mascarenhasia*, *Funtumia*, and *Ficus*, are of the most importance.

The genus, *Mascarenhasia*, is said to possess several species of value, but it is doubtful whether their produce is of much importance in the rubber export from Africa. *M. lisianthiflora* DC., yields latex from which rubber possessing 88 to 91 per cent. of caoutchouc has been obtained; *M. anceps*, Boiv., and *M. longifolia*, Jum., are also said to yield good caoutchouc, whereas the products from *F. elastica*, Schum., and *M. utilis*, Bak., are described as being of doubtful value.

The genus, *Ficus*, possesses several species which are exploited by African rubber collectors: among those of note, may be mentioned *F. Vogelii*, Miq., *F. Whytei*, Stapf., *F. guineensis*, Stapf., and *F. Johnstonii*, Stapf.

Funtumia.—This genus has lately become well known as a source of rubber in Africa. It is still much confused with the genus *Kickxia*, and it is as well to again point out that Africa does not possess a single species of *Kickxia* of value as a rubber-producing plant. The four species of *Kickxia* acknowledged by Stapf, are found only in Java, Celebes, Philippine Islands, and Borneo. The genus, *Funtumia*, is partly African, and is represented by three species—*F. elastica*, Stapf, *F. africana*, Stapf, and *F. latifolia*, Stapf.

The species of importance as a source of rubber in Africa is *F. elastica*, Stapf; its occurrence has been recorded in Liberia, Gold Coast, Ashanti, Lower Nigeria, Cameroons, Mundame, French Congo, Congo Free State, Uganda, &c. The rubber from this species is very valuable, possessing, when properly prepared, from 80 to 90 per cent. of caoutchouc. *F. elastica* has been described as a tree with a cylindrical trunk which attains a height of 100 feet; sometimes the trees occur more abundantly in local areas; and out of an area of about 54 square miles as many as 1,760,000 trees have, as previously stated, been estimated to occur.

Eastern Rubber Plants.

A few remarks can now be made regarding some indigenous species in the Indo-Malayan region. The most noteworthy genera are *Ficus*, *Cryptostegia*, *Leuconotis*, *Parameria*, *Urceola*, *Willughbeia*, *Chonemorpha*, *Ecdysanthera*, and *Rhynchodia*.

Ficus.—The tree known as *Ficus elastica* (L.) indigenous in Assam, Burma, and Malaya, furnishes a large proportion of the wild rubber exported from India. It grows to an enormous size, but cannot be tapped until it is many year's old. It does not appear to have given as good yields either in the Indo-Malayan region, where it is indigenous, or in parts of West Africa, Egypt, and Ceylon, where it has been introduced. A species of *Ficus* has been exploited in British New Guinea, but as yet the reports regarding this are not very encouraging. The latices from *Ficus comosa* and *Ficus indica* sent from the Botanic Gardens, Calcutta, were examined by the Imperial Institute, London, but as they contained about 80 per cent. of resinous matter were reported upon as being almost worthless.

Cryptostegia.—The genus *Cryptostegia* furnishes two species of value as sources of rubber : *C. grandiflora*, Bra., and *C. madagascariensis*, Boj.; these are both lianes, and the former occurs in India. Many consider that *C. grandiflora* is an Indian species naturalised in Madagascar, whilst others consider it to have been introduced into India from Madagascar. It is cultivated in a few gardens in India; the rubber is of fair quality, possessing about 80 per cent. of caoutchouc, though the harvesting, as at present carried out, is rather costly.

Leuconotis.—Plants of *Leuconotis eugenifolia*, DC., occurring in Penang, Sumatra, and Borneo, and *L. anceps*, Jack., of Borneo, yield very poor rubber; *L. elastica*, Becc., of Borneo, is, according to Beccari, a plant which yields an excellent rubber, and the latex of *L. subavenis*, Boerl., also common in Borneo, is said to be used for adulterating purposes.

Parameria.—The liane, known as *Parameria grandulifera*, Benth., found more or less frequently in the Malay Peninsula, Burma, Andamans, Borneo, Philippines, &c., is said to yield a fair rubber; the dry material may possess over 90 per cent. of caoutchouc. The latex of *Parameria fedunculosa*, Benth., has been reported upon by the Imperial Institute, but as the dry material possesses 88 per cent. of resin and only about 10 per cent. of caoutchouc, it cannot be said to be of much value.

Urceola.—Several species of this genus have been reported as yielding fair quantities of useful rubber. *Urceola esculenta*, Benth., common in British Burma and other parts of India, may yield dry rubber possessing 75 to 80 per cent. of caoutchouc. *M. elastica*, Roxb., found in Malaya; *U. acute acuminata*, Boerl., occurring in Borneo; and *U. Maingayi*, Hook, f., found in Singapore and Borneo; these are described as yielding latices sometimes rich in caoutchouc. There is one species —*U. brachysepala*, Hook, f., which occurs in Malaya, Borneo, and Java, and is, according to Jumelle, capable of being cultivated up to an altitude of 700 metres, and from which 25 grammes of caoutchouc have been obtained per plant.

Willughbeia, &c.—The plants of the genus *Willughbeia* grow into huge climbers analagous to the *Landolphias* of Africa; two species have been reported upon for their caoutchouc-yielding properties. *W. firma*, Blume, occurs, according to Stapf, in Sumatra and Borneo. It grows sometimes to a length of 40 metres, but the rubber from this species as it arrives in Europe loses sometimes as much as 4 per cent. in washing. The latex of *W. edulis*, Roxb., a species common in some parts of Assam and Malacca, yields a very resinous rubber possessing only about 10 per cent. of elastic caoutchouc-like substance.

The reports of the Director of the Imperial Institute on the rubber obtained from *Chonemorpha macrophylla* and *Rhynchodia Wallichii* from Burma, and the latex of *Ecdysanthera micrantha* from Rangoon, show that in these plants there is much of interest to rubber cultivators.

It is obvious from the foregoing that there are very many species of rubber-yielding plants scattered throughout the tropical world. We may now proceed to study the wild and plantation species, and the nature of the channels in the tissue of these plants wherein rubber accumulates.

Wild Rubber.

Hitherto wild rubber has been obtained from forest trees or vines indigenous in local areas, and has been collected mainly by native labourers who have bargained their harvests for articles of food, &c., and who in their work have adopted methods requiring the minimum skill and involving the destruction of the plants. To-day the business of rubber exploiting in tropical America and Africa is being supervised by companies who are aiming at the preservation of the original wild plant, and in some cases the re-afforestation of areas poorly represented in wild rubber species, by indigenous or introduced rubber-yielding trees of known value. The terms under which much land has been leased provide that a definite acreage shall be planted each year, thus ensuring that the sources of supply shall be maintained.

Importance of Wild Rubber Supplies.—The sources of wild rubber are receiving much more consideration and care than was the case a few years ago, and may for many years to come be expected to annually supply the equivalent of approximately 1,000,000 acres of plantation rubber; should the supply from wild sources become scarce—an improbable occurrence—it would be impossible for the plantations to supply the balance for many years to come, as the producing capacity of the land now alienated for rubber in the East will only be, in 1912 or 1913, some 12,500 to 25,000 tons per year. The rubber manufacturers have hitherto been dependent, almost entirely, on wild rubber; and it seems illogical to suggest that the rubber forests on which so much new capital and enterprise have been recently expended, and in which prominent scientific and business men are concerned, will be unable to satisfy the increased demand expected in the next few years; it may confidently be regarded as the principal source of rubber for the next half-score of years, for the simple reason that plantations in the proper sense do not exist to produce what will be required.

Developments in Wild Rubber Areas.—Though the extraction of rubber from indigenous trees, vines, and shrubs in African and American forests has been hitherto mainly carried out at the sacrifice of the plants yielding caoutchouc it must not be surmised that this practice is always adopted. Most of the companies of recent birth, formed for the exploitation of rubber from wild sources, are paying attention to the planting of areas which possess a fair proportion of rubber trees.

Many English companies operating in America and Africa are developing their properties in this manner, but for present purposes I cannot do better than give you an idea of what is happening in the Congo State, according to information obtained authoritatively and placed at my disposal by Mr. Johnston, of Little and Johnston, London. The information was obtained, I understand, from M. Arnold, Minister of Agriculture, Brussels, who has kindly sent numerous rubber samples, now submitted for your inspection. You will notice that rubber samples, labelled as follows, are included:—*Funtumia elastica*, *Landolphia Klainei*, *L. Gentilii*, *L. owariensis*, *L. Thollonii*, *Clitandra Arnoldiana*, *Ficus elastica*, *F. negbudu*, *Manihot Glaziovii*, *Hevea brasiliensis*, as well as material from Lake Leopold II., Uelle, Aruwimi, Equator, Mongala, Lopori, and Kassai, in the Congo. Most of the material represents what can be obtained from plants indigenous to the Congo, but *Ficus elastica* is native to India and Malaya, and *Hevea* and *Manihot* to tropical America. The following are some interesting extracts from the translation :—

" The State Laws, since the year 1899, have prescribed that there shall be planted annually a number of trees or creepers which shall not be less than 150 for every ton of rubber collected during the same period. In 1902, the number of rubber trees or creepers to be planted annually under the conditions fixed by law was increased from 150 to 500. In 1904 a new decree was made stipulating that whoever collected rubber in the forests or State lands, is bound to plant annually at least fifty young rubber trees or creepers, and fifteen root rubber plants per 100 kilograms or fraction of 100 kilograms of fresh rubber collected during the same period.

" On the 1st of January, 1906, the rubber plantations, established by the State, included nearly 9,500,000 plants, of which 8,575,000 were creepers, 750,000 *Funtumia elastica*, and 157,000 different trees, including *Hevea brasiliensis*, *Manihot Glaziovii*, *Ficus elastica*, *Castilloa elastica*, and *Castilloa Tunu*.

" To avoid losses resulting from the bad choice of land, the Government has authorised that supervision of the rubber plantations shall be made in each district, either in execution of the legal provisions or in conformity wth Government instructions, at one or several places recognised as being favourable to rubber cultivation by the State agriculturists, the latter being charged with the supervision of plantation on behalf of the State.

" In 1906 the State sent more than 20,000 seeds of *Hevea brasiliensis* to the Congo . . . . orders for seeds for 1907 have already been given; at least 100,000 seeds will be sent.

" The State has decided to give extension to the cultivation of *Hevea brasiliensis* in the Congo.

"The State has procured 15 different instruments for tapping, reviving, and strengthening the rubber plants."

The same might be said of developments in almost every other part of tropical Africa and America, but the above will serve to show that there is likely to develop a pseudo-wild source of rubber in the future.

In some parts of Africa the trees of *Funtumia elastica* are said to sometimes occur in clusters and in such areas to be very abundant. In parts of Mexico and Brazil investigated by many botanists, *Castilloa*, *Hevea*, *Sapium*, and other species are said to occur frequently. But it must not be concluded that in such areas there are always large numbers of mature and tappable trees; in many parts of Mexico I have been assured, by a prominent resident there, that it is rare that one finds more than one or two trees of *Castilloa elastica* to an acre of land; what trees did exist in days gone by have been largely destroyed or rendered almost valueless by ruthless native tapping, and one can but conclude that in many instances the profits from the few wild scattered trees will be largely swallowed by the expenditure involved in the employment of skilled men in searching for them; of course, they are worth having, but their fewness makes one wonder whether the wholesale clearing of forest prior to planting, as adopted in the East, where wild rubber trees do not exist, is after all a serious disadvantage.

Change in Wild Rubber Areas.—The material exported from the wild rubber areas in America will probably retain much of its present character, whereas that from tropical Africa may show considerable changes in the future and tend to become somewhat similar to that from America. This is suggested from a study of the developments which are now going on in both countries; in American areas attention is mainly directed to the cultivation and exploitation of species indigenous there, and though a few species of *Landolphia*, *Funtumia*, and *Ficus* from Africa and the Indo-Malayan region have been tried, they do not appear to give very satisfactory results. On the other hand, nearly every part of tropical Africa is carrying out extensive experiments with *Hevea*, *Manihot*, and *Castilloa* species from America, and in consequence of the success which has already been achieved one of the three American genera is likely to be largely adopted. The cultivation of climbing plants and of root rubbers is generally more difficult and expensive than that of arborescent forms, and it appears probable that the produce of the latter will largely increase, and that of the former decrease in quantity. Judging from results obtained it appears to me, though I may be quite wrong, that the cultivation of species of *Hevea*, *Castilloa*, *Funtumia*, *Manihot*, *Sapium*, and aborescent forms similar to them, will predominate in the future, and that of species of *Landolphia*, *Cryptostegia*, *Clitandra*, *Carpodinus*, and *Willughbeia*, gradually become relatively insignificant; plants of the former group require less supervision, they attain maturity at an earlier age, they allow of continuous tapping operations for several years on the same tree, and under certain conditions yield rubber in larger quantity than do those of the latter class.

In the Indo-Malayan region, the indigenous species of *Cryptostegia*, *Leuconotis*, *Parameria*, *Rhynchodia*, &c., and even of *Ficus* and *Sapium*, are gradually being neglected in preference to those from tropical America. There the species of *Manihot*, *Ficus*, and *Castilloa* do not appear to give as favourable results as *Hevea brasiliensis*, and before very long that area will stand out remarkably for the uniformity of the greater part of its exported rubber. *Hevea brasiliensis* appears to have been taken up in the East, almost to the exclusion of all other rubber-yielding plants, and even the coconut palm has been felled in order to make room for this favourite species. It is very rare, in Ceylon, that one meets with plantations of *Castilloa*, such as are described to exist in Mexico, or of *Manihot* as in parts of Brazil.

Differences Between Wild and Plantation Areas.

Eastern rubber estates are nearly all planted; only a few possess indigenous trees or climbers, and the waiting period is consequently very long; properties in Malaya, possessing trees of the indigenous *Ficus elastica*, have nearly all been regularly and systematically planted with seedlings reared in the nursery, and in this feature differ from the wild or pseudo-wild areas.

Again it may be stated, with some amount of accuracy, that the rubber output from most parts of tropical America and Africa is dependent upon native efforts; there the amount of skilled supervision is small compared with that on planted estates generally. I have been informed by residents in prominent wild-rubber areas that they have only a few practical men of repute. In Ceylon, Southern India, Federated Malay States, Straits, &c., the estates are managed by Europeans of considerable tropical experience, and their systems of keeping records and accounts, and their knowledge of engineering, languages, &c.—all of which play a very important part in the ultimate success of any rubber plantation—are such as to command complete confidence. The number of planters drawn from Ceylon to engage in the rubber industries of the Malay Archipelago is very large, and from a few years' experience in that island one can anticipate that good work will be done.

It is now generally admitted that *Hevea brasiliensis* has, on Eastern plantations, been proved to give excellent results, and to stand tapping operations even of a very drastic nature; this cannot yet be asserted for many *Castilloa* plantations in Mexico and Central America, or even for those of Ceara in Brazil, or *Landolphias* and *Funtumias* in Africa, though we naturally expect favourable results from many of these.

Plantations of rubber trees are capable of being worked more economically than forests of mixed plants ; the number of rubber trees is generally accurately recorded, they are capable of being minutely inspected daily, and there are often more rubber trees in one acre of an Eastern plantation than in several square miles of American and African forest. Of course, it is possible to plant up areas possessing indigenous rubber-yielding plants, but the abundance and cheapness of the Indian, Javanese, and Malay labour make it possible to do planting work cheaper in the East than in most parts of the tropics.

It is asserted by many that tropical plants will thrive best in their native habitats; this statement can be seriously contested, and is often contradicted by the results obtained from introduced plants in the tropics. True, the indigenous rubber-producing plants in the American and African forests represent types which, in their native countries, have survived in the struggle for existence, and have often successfully contested certain pests. But it is well known that a change of climate is often beneficial to the plants, and certainly the results obtained with introduced species in the East justify one in anticipating that the rubber plantation industry will give satisfaction to most persons interested in it.

Distribution of Rubber Plants and the Eastern Industry.

At the present time it may be stated that many trials of Brazilian species have been made in Africa, East and West Indies, India, Malaya, Borneo, Philippines, New Guinea, Fiji, &c., and of African species in parts of America and the East and West Indies. In the distribution of rubber-yielding plants to various parts of the British Empire Government have taken considerable interest.

The gradual development of the plantation rubber industry can be associated largely with the activity of the various Government Botanic Departments in different parts of the world. The Royal Gardens, Kew, naturally ranks of first importance in this respect, as a centre of distribution of species collected from all parts of the tropics. According to the Kew Bulletin (No. 3, 1907), *Hevea brasiliensis* was first sent from Kew to India in 1873; in 1876 to Burma, Ceylon, Java, Singapore, West Indies; in 1877 to Mauritius and West Africa; and in 1878 to Fiji. Plants of *Hevea spruceana* were first despatched to Ceylon in 1883; to India, Java, Singapore, West Africa, and West Indies in 1887; and to Fiji in 1893. *Castilloa elastica* was first sent to India in 1875; to Ceylon, Java, and West Indies in 1876; to Singapore, Mauritius, and West Africa in 1877; and to Fiji in 1882. *Manihot Glaziovii* was first sent to India, Ceylon, Singapore, and West Africa in 1877; and to Java, Fiji and the

West Indies in 1878. *Landolphia* plants were first despatched to Ceylon and the West Indies in 1880; to Singapore and Fiji in 1881; to Mauritius in 1883; and to Java in 1888. *Funtumia elastica* was sent from Kew to India, Ceylon, Java, Singapore, and the West Indies in 1896, and a second consignment was forwarded to the same countries in 1897.

Ceylon.—The Ceylon Para rubber industry has been developed from the offspring of the plants originally obtained by, and for, the Indian Government in 1876 and 1877. These plants were sent to Ceylon, in whose Botanic Gardens they were carefully reared, and supplies distributed to many parts of the world.

As explained above, plants of *Castilloa elastica*, *Manihot Glaziovii*, and species of *Landolphia*, *Sapium*, *Palaquium*, &c., have also been received in Ceylon, from Kew and other Botanic Gardens direct. Rubber plants have been sent from Ceylon to the Straits, Borneo, Java, Philippines, Seychelles, Queensland, New Guinea, Africa, West Indies, and even Brazil.

Singapore.—The Botanic Gardens at Singapore have also received many rubber-yielding species from Ceylon, and other countries. Mr. H. N. Ridley has kindly supplied me with the following information:—Twenty-two plants of *Hevea brasiliensis* were received on June 11th, 1877, from Kew, and a further consignment was despatched from Kew in the following year; already very large and successful acreages have been planted from the offspring of these parents. In 1876, plants of *Castilloa elastica* and *Manihot Glaziovii* were received from Kew; the former were failures, and the latter are not looked upon with favour in the Straits. In 1898, plants of *Funtumia elastica* and *Mascarenhasia elastica* were received from Kew, but they appear to grow very slowly. Plants of the vines—*Landolphia Watsoniana*, *L. petersiana*, and *L. Kirkii* were received in 1881 from Kew, but none have been successful as cultivated plants, though nearly all grow well. In the same year a species of *Hancornia*, which subsequently failed, was also received from Kew. *Ficus elastica*, at present largely cultivated in the Straits and Federated Malay States, was received at Singapore before 1875. It is a native of Perak, and caoutchouc from wild trees of this species was obtained before 1876.

India.—My information regarding the introduction of rubber-producing species to India has been obtained from Mr. I. H. Burkill, Officiating Reporter on Economic Products, Indian Museum, Calcutta. For many years thousands of seeds of *Hevea brasiliensis* have been annually sent from the Henaratgoda Botanic Garden, Ceylon, to the Government of India, and in addition to these, officials and planters have frequently secured seed supplies of other species from Ceylon and the Federated Malay States. I append a synoptical statement, showing the date of introduction of the more important foreign species, at present in India, supplied by Mr. Burkill :—

INTRODUCTION OF RUBBER PLANTS TO INDIA

Species.	When Received.	Whence.	No. of Plants.	Results obtained.
Hevea brasiliensis ...	1873	Kew	6	Not favourable.
,, ,, ...	1876	,, ...	50	Reached in bad condition.
,, ,, ...	1877	,, ...	50	Did well.
,, ,, ...	1879	Ceylon	178	Fully established.
Castilloa elastica ...	1881-1882	,, ...	2	Not passed experiment stage.
Manihot Glaziovii...	1877	Kew (50)...	50	Not passed out of experiment stage.
Funtumia elastica ...	1899	West Africa seeds yielding	1,000	
,, ,, ...	1903	Trinidad, 1,000	—	Not passed experiment stage.
,, ,, ...	1904	Trinidad, 8,000 seeds ...	—	
Other species—				
Landolphia Kirkii ...	1878-1879	Zanzibar seeds	—	Failed.

Plantation Rubber.

These considerations bring us to the subject of the plantation rubber industry as at present developed in the three great rubber areas. Its exact importance in areas where indigenous species are exploited is difficult to ascertain, and the various compilations regarding this point show considerable differences in areas planted. Dr. Olsson-Seffer states that *Castilloa* is being planted over large acreages in Central America and Mexico, and according to him this work is proceeding in Guatemala, Nicaragua, Panama, Costa Rica, Honduras, and San Salvador; in the Central American Republics there are reported to be about 12,230 acres under rubber, mainly *Castilloa elastica.* In Mexico, according to Seffer, on December 1st, 1906, there were about 82,620 acres planted with a prospect of planting 10,000 acres more in 1907. Seffer states that "this area under cultivation represents at least £6,000,000 that are nominally invested in rubber plantations." In Ecuador, property owners have begun to plant trees of *Castilloa elastica*, and plantations now exist "especially round the Balzar and Fenguel districts and in some parts of the provinces of Manabi and Esmeraldas." The latest official report states that there are about one million trees now planted in Ecuador, and that over 95 per cent. of the present export is of wild rubber and only 5 per cent. of cultivated rubber. It is difficult to obtain any reliable information regarding the planted acreage in Brazil, the West Indies, and Africa, and beyond stating that the operations contemplated are on a very large scale, I do not propose, at present, to commit myself.

Indo-Malayan Plantation Rubber.

We do, however, possess some detailed knowledge regarding the plantation industry in the East; and as Ceylon, Straits Settlements, the Federated Malay States, Southern India, Borneo, &c., are now of considerable importance, in this respect, we may devote some attention to this area.

Southern India.—Mr. Windle, in his lecture at the Ceylon Rubber Exhibition in September, 1906, made the following statement :—

"In 1903 some good-sized areas were opened, and since then planting has been extending fast. I should put 1904 as the year in which, with the exceptions mentioned, Southern India really began its serious planting of rubber. As to areas open at the present time, I have done my best to collect some figures on the point, and am fairly certain that they are not under the mark :—

	Acres.
The Nilgiris and S. Wynaad	1,200 mostly in coffee (Para chiefly)
Malabar and S. Wynaad ...	400 (Para, Castilloa and Ceara)
Coimbatore	1,100 (Para)
Cochin	1,000 ,,
Travancore	6,000 ,,
Shevaroy Hills	1,200 (mostly Para in coffee)
Pulneys	100
Mysore	—
Coorg	2,000 (chiefly Ceara)

Since the above statement was made several companies have commenced active operations in the Travancore district and also in Burma. We may soon expect to see, in Southern India and Burma, about 20,000 to 30,000 acres of planted rubber.

Ceylon.—The island of Ceylon has evinced considerable activity in the planting of rubber trees, as the following figures will indicate :—

Year.		Acreage.	Year.		Acreage.
1898	...	750	1903	...	7,500
1899	...	1,250	1904	...	11,000
1900	...	1,750	1905	...	40,000
1901	...	2,500	1906	...	100,000
1902	...	4,590	1907	...	130,000 (estimated.)

The importance of this acreage will be manifest when it is remembered that that under tea, which has been long established in Ceylon, is only 382,000 acres, and that under cacao 34,000 acres.

Malaya.—In the Federated Malay States a total of 150,000 acres has been reported as alienated for rubber. According to Carruthers, the following is the estimated average for the middle of 1906 in the Federated Malay States :—

Under one year old	25,000	acres.
One year and under two years old ...	15,000	,,
Under three ... ... ,,	4,500	,,
Under four ... ... ,,	4,000	,,
Under five ... ... ,,	8,500	,,

Other authorities estimate that in Malaya, Malacca, Sumatra, &c., there were at the end of 1906 about 90,000 acres planted; in Java about 20,000 acres; and in Borneo about 12,000 acres. Before very long we hope to be able to definitely state that in the Indo-Malayan region alone there are one-quarter million acres of planted rubber trees, mainly of *Hevea brasiliensis.*

Planting of Rubber Trees.

A very responsible journal, viewing the probable future developments less than two years ago, predicted that by the end of 1906 there would be planted in the East about 100,000 acres of rubber trees, and suggested that an average yearly increase to the plantation rubber acreage in the East might be taken in round figures at 20,000 acres. But it is obvious from previous considerations that there are now nearly one-quarter of a million acres, while the propositions now being considered in London alone suggest that during the next few years the annual increase in planted acreage is likely to be on a very large scale, especially in Ceylon, Malaya, Borneo, Java, and Sumatra.

Thousands of acres have been planted during the last two years, and the progress of events in Ceylon is of interest, since we have seen that that island, by its phenomenal activity, has planted more since the beginning of 1905 than it did in the whole of the previous twenty years, though seeds were then available.

The recent activity in Ceylon has placed that small island, as far as insular plantation acreage is concerned, in the first position in the British Empire, but how long it will hold that position it is difficult to foresee. Furthermore, Ceylon doubled its rubber production in 1906 over 1905, the amount produced, less that re-exported from the Straits and China, being approximately 140 tons.

Importance of Plantation Supplies.

The future importance of plantation rubber is one which cannot be neglected, especially in view of the enquiries regarding the supplanting of wild rubber by that from plantations. There can be no doubt about the question of economy in the two classes: very many of the wild-rubber areas in Africa and America are now being gradually transformed into plantations of some kind or other. The general tendency of present-day operations is to lead to an extension of regularly-planted estates where wild-rubber forests or ordinary forests previously existed and a reduction of genuine wild-rubber areas; in view of these facts it seems desirable to determine the equivalent of the wild areas now exploited in terms of plantation acreage. Assuming that the consumption for 1906 was 65,000 tons, what plantation acreage would be required to supply that amount? During 1905 and 1906 the trees on plantations in Ceylon, Federated Malay States, Straits Settlements, and parts of Southern India, gave an average annual yield of 1 to 1½ lb. of dry pure rubber per tree. If the minimum yield is ¾ lb. per tree per year, from estates planted twenty by fifteen feet apart, the yield per acre is at the rate of one ton of pure rubber per twenty acres; if you allow at the rate of 1½ lb. per tree, which is by no means excessive where labour for tapping is available, you have one ton of rubber per year from every block of ten acres. The 65,000 tons of wild rubber supposed to have been produced in 1906 may be roughly estimated to have contained about 20 per cent. of impurities, so that its equivalent in pure plantation rubber would be about 52,000 tons; to produce this amount, 1,040,000 acres would be required on the minimum estimate, or 520,000 acres only on the estimate of 1½ lb. of pure rubber per tree. It is obvious from the figures given elsewhere that the plantation acreage in the Indo-Malayan region alone already promises to be not much less than 250,000 acres.

Those calculations give you some idea of the position of the present plantation acreage in the East in relation to last year's consumption. But it may be logically stated that this is a false standpoint to argue from, since the trees on the land alienated for rubber to-day will not be in bearing for many years to come, and in that interval the consumption will at least show the normal yearly increase; these are contentions which cannot be negatived. If it is assumed that the world's consumption will increase at the rate of only 5,000 tons per annum, and that the output from wild sources will remain constant at about 60,000 tons per year, you may still require in 1913 no less than 640,000 acres of cultivated plantations to supply the material above that produced from wild sources. It is fairly safe to reckon that 80,000 additional plantation acres will be required every year to supply the annual incremental increase in consumption of 5,000 tons of wild rubber. It is believed that more than that amount will be planted yearly, and, therefore, that plantation rubber will sooner or later obtain a prominent, if not the commanding, position as a source of future rubber.

Plantation and Wild Rubber Supplies.

In the past, wild rubber has controlled the market of the world, and must continue to be of ruling importance during the next few years. There are a few people who believe that it will always occupy a dominant position, and that plantation rubber can never do more than supply a small fraction of the yearly incremental increase which manufacturers demand. The exact position of the wild, plantation, and what may perhaps be termed the pseudo-wild rubber supplies in the British Empire, and in islands and territories belonging to other nations, is difficult to ascertain, but I think it can be shown that in a very small fraction of the Indo-Malayan region, to say nothing of our West Indian islands or of the vast African territory, we are preparing to take an important and perhaps predominant position as producers of rubber from organized and well-kept tropical plantations. We have more than sufficient land available in the tropics to supply double or treble the amount of the world's consumption for 1906, and can already—barring unforeseen disaster—promise to supply from 12,500 to 25,000 tons of pure rubber from the acreages now planted in Ceylon, Federated Malay States, Borneo, South India, Java, and other adjacent islands. The position is so strong and promising that one may be excused for believing that if the extension in rubber cultivation continues as it has done for the last few years, the ultimate condition of low prices and abundant production is not far distant; such changes may, however, be of much benefit to the industry. Wherever you go in the countries just mentioned, the one great topic which is commanding attention, energy, and capital, is that of the cultivation of rubber-producing trees, and but few other products can, in the tropics, hope to receive the consideration they deserve, until the rubber craze has been satisfied. The plantation rubber industry in the East has already made a good name, and no one who possesses an intimate knowledge of the present position and probable future developments, can deny that it has gone to stay. The success, which has attended many ventures, has arrested the attention of responsible officers in all parts of the world, and it will interest you to learn that thousands of seeds of *Hevea brasiliensis* were sent back to Brazil, from Ceylon, for planting purposes, during 1906, in addition to very large numbers of seeds and plants to Africa, West Indies, Borneo, Sumatra, Java, and parts of India, etc.

During my short stay in England, I have had the pleasure of meeting several rubber manufacturers, and my confidence in the plantation industry has been increased in consequence of the information they have given me, and their willingness to book forward contracts for the next ten years, at prices which will well repay the cultivators in the tropics.

Future Plantation Output.

Up to the present the cultivated trees have not supplied much rubber, but it is necessary to point out that five years ago rubber cultivation was not favourably viewed, and it is only in the last few years that the acreage has increased by leaps and bounds, out of all proportion to the gradual development of more remote years. In Ceylon, from 1890 to 1898, the acreage only increased at the rate of about 50 acres per year, and in 1898 was estimated at approximately 750 acres; three years later rubber was planted on 2,500 acres, in 1904 it occupied 11,000 acres, in 1905, 40,000 acres, and last year, 100,000 acres; and similarly in other Eastern possessions. I again mention these figures to draw attention to the fact that the planting of rubber trees during the last two years in the Indo-Malayan region alone has been on a comparatively large scale, and that we may therefore expect to see a sudden increase in the amount of rubber on our markets a few years hence. Ceylon alone has already planted land sufficient to supply London with about 7,000 tons of rubber per year in place of the 70 tons she sent in 1905; land is being applied for and purchased at very high prices, and very soon a prominent and permanent position will be established. When one considers what has recently happened in Ceylon, the Federated Malay States, and India, it is obvious

Photo by H. F. MACMILLAN.

Mature Para rubber trees along river bank.

that the export in a few years will be as suddenly increased as has been the planted acreage in these countries, and for this we must be prepared.

Purity and Constancy of Plantation Rubber.

One of the outstanding features of the future plantation rubber industry will be its constancy, not only in output but in purity, and also probably in form and physical property. The acreage of each estate is usually well known, and the accuracy of the output per year will be guaranteed just as it is on mature estates of other products in the tropics. The consumers may rest assured that adulteration will never be adopted, first because there are no trees of such yielding capacity as those under cultivation, and secondly because the estates are mainly under the supervision of Europeans who are only too anxious to establish a fair name for their produce; any changes in chemical and physical properties which may occur in the rubber exported in the future will either be due to a change in the mode of manufacture or to the increasing age of the tapped trees—two possibilities which suggest improvement rather than retrograde development. It is almost certain that the form of the future rubber will be one which will minimise the liability to oxidation and development of tackiness in transit, and one which will commend itself for ease in handling and shipment.

Improvements in physical properties are to be expected year by year as the trees grow older; what Europe and America are receiving to-day from plantations are only the worst and most crude samples of rubber, for the planters do not know what is really required—the industry is in its elementary stage, and all may rest assured that no efforts or expenditure will be spared which will help to place the cultivation of rubber trees on a sound basis.

Rubber Consumers and Producers.

There is one point which, while dealing with plantation rubber, I cannot omit to mention. I refer to the want of unanimity between producers in the tropics and consumers in Europe and America, to the lack of authoritative information from consumers as to what they wish their colonial producers to turn out. Planters in Ceylon, India, and the Federated Malay States, are very anxious to find out what form of preparation the manufacturers most desire, and the fact that within twelve months they have sent home their plantation rubber in the form of biscuits, sheets, crêpe, lace, flake, ribbons, balls, block, pressed scrap, washed scrap, hand-picked scrap, in the smoked and unsmoked condition, dry and wet, naturally and chemically coagulated, and in many other forms and conditions should be sufficient to indicate the manner in which they are endeavouring to meet whatever requirements may be stipulated. The producers desire to adopt methods which will enable them to dispose of the large volumes of latex speedily and to pack and ship the rubber with the greatest security and ease.

Will the manufacturers be good enough to state whether they prefer rubber which has not been obtained by the use of chemical re-agents, or if they object to the washing of the freshly-coagulated material? We should also like to know if they prefer to receive it free from moisture, in the smoked or antiseptic form, and whether they pre-

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fer rectangular thin sheets, thin blocks, or biscuits. A definite statement from the consumers would be heartily welcomed by the producers, it would obviate much waste of time and money, and lead to the establishment of definite standards for exports at an early date.

Effect of Rubber on other Cultivations.

The planting of rubber trees necessitates the destruction of the original forests, but sooner or later a new forest takes the place of the old. The cultivation of rubber vines (*Landolphia*) does not incur the destruction, but demands the retention of a part of the original forests, as the vines must have some means of support, or stems of living plants along which they can climb. Rubber cultivation is therefore fundamentally different from that of tea, cotton, camphor, etc., and in many cases leads to the re-afforestation of areas which have been allowed to lapse into waste compounds or chena land.

The extensive cultivation of rubber trees will directly affect many other products cultivated in the tropics. At the present time *Hevea brasiliensis* is being largely planted among tea in Ceylon and South India, among coffee in Sumatra, Java, and South India, and among cacao in Ceylon. *Castilloa elastica* is being extensively grown with cacao in the West Indies, and to a small extent in Ceylon. *Ficus elastica* is grown with coffee in Sumatra. The distance of the rubber trees from one another is generally such that the intercrop of tea, coffee, and camphor will ultimately be choked out, and only in the case of cacao does the combined cultivation appear to be of a more or less permanent character. Furthermore, there are vast areas in the Federated Malay States where cassava or tapioca and gambia are grown on the land as soon as the jungle has been felled and cleared. In Ceylon, minor crops of chillies, hill paddy, bananas, tapioca, lemon grass, and citronella, are cultivated; in other countries, tobacco, indian corn, and other plants are grown on new land. These areas are now being rapidly interplanted with rubber trees which, once they have reached maturity, will not permit of the cultivation of the intercrops and catch crops, which are of such importance to natives and commerce generally. In some countries, where the faith in rubber alone has not yet taken a very firm position, the majority of the lands already under other products are being interplanted with rubber species.

In Ceylon, during the last few years, a large area of the poorer low-country tea has been interplanted with *Hevea brasiliensis*, and there can be no doubt that in three to five years' time the greater part of such tea will no longer be plucked; the same may be said of much coffee in Southern India and in various Indo-Malayan regions. Now, however, the tendency appears to be to plant *Hevea brasiliensis* as a single product, when land is available.

Though this is the case with tea and coffee, the effect on cacao in Ceylon appears to be the reverse. In the Matale, Dumbara, Kurunegalle, and other districts of Ceylon, *Hevea brasiliensis* and cacao (or cocoa) are being largely planted on new clearings as a combined cultivation; the plants are generally distanced so that there are about 100 rubber and 100 cacao plants per acre; under such conditions, both appear to thrive for many years, and to yield fair harvests in the fifth or sixth years.

Land planted in coconuts is usually not interplanted with rubber species; in one country coconuts have been felled and removed to make room for the rubber trees.

Camphor as an intercrop among rubber is, in the tropical parts of the British Empire, as yet only in the experimental stage.

To sum up the effect of the combined cultivation, it may be stated that much tea and coffee will be killed out, the acreage in cacao increased, and the available land for catch crops of oil grasses, bananas, chillies, etc., be ultimately permanently reduced.

Laticiferous and Caoutchouc Plants.

It is necessary to explain that numerous plants possess latex in large quantities, but the viscous liquid is often almost useless on account of the low percentage of caoutchouc or the high percentages of albuminous, resinous, and other substances present. Everyone must have noticed the milky liquid which issues from the cut surfaces of *Sonchus arvensis* and species of *Euphorbia*—plants which occur abundantly in parts of England; in the tropics there are many plants, such as species of *Carissa* and *Plumeria*, *Euphorbia Tirucalli*, *E. Antiquorum;* climbers or lianes, *Cryptostegia grandiflora*, *Willughbeia zeylanica*, which almost squirt out large quantities of latex when cut with a knife. The same may be said of *Palaquium* and *Bassia* in Ceylon—genera from which the gutta-percha of commerce is obtained, but which in the island mentioned yield latex of very little commercial value. The latices of importance usually possess high percentages of caoutchouc—the compound which largely determines the uses to which the dried product can be put. If one considers species of the same genus, the striking fact is revealed that the chemical composition of the latex is almost of specific importance. There are many species of *Hevea*, *Landolphia*, *Ficus*, and *Funtumia*, but only certain members possess high percentages of caoutchouc and low percentages of resins and proteids.

The Laticiferous System.

All the species which have been previously mentioned are characterized by systems of sacs, series of cells, or tubes containing latex; these occur in nearly all parts of the plant. The commercial possibilities and the ultimate success of several species are determined by the particular type of laticiferous tissue which each contains; each type requires to be dealt with in a particular manner: it is very dangerous to adopt the same methods of tapping for all species. The principles of paring and pricking the primary and renewed cortex should be studied more seriously and intelligently than they appear to be at the present time. When one considers the great difference in the nature, mode of origin, and development of the laticifers in various plants, there is every reason for suggesting that each species should be tapped on a particular system in order to take advantage of the peculiarities of each type. These remarks are made because there is a tendency among responsible persons to recommend or adopt for their *Castilloa*, *Manihot*, *Funtumia*, *Landolphia*, and *Ficus* plants, the system of tapping which has been found to be so successful with *Hevea brasiliensis*. From a study of the laticiferous system of our prominent plants, I am convinced that in certain instances the old, native, and apparently wasteful, methods adopted in the extraction of latex are probably as good as, and even better than, many which have been evolved.

The laticiferous system in several of our important species occurs in the cortex of the stem, branches, roots, and in the leaves, flowers, and fruits. In some species the laticifers appear to be best developed in the root, and the extraction of latex is only considered in relation to that part; in other species there appears to be a better development in the stem, and in a few others the flowers or young twigs show conspicuous developments. Generally, these structures and the latex appear in the embryo and remain until the death of the plant; in some cases, however, the laticifers are not obvious except in plants of some years' growth. Sometimes they are absolutely restricted to stem and roots, the leaves and flowers never being in possession of such structures; in a few cases they appear in the young tissues, and then gradually die and disappear.

For the purposes of this paper it will perhaps be sufficient to state that there are three types of laticiferous systems, the components of which are scattered freely throughout the cortex in the stem; they may, according to their age and the condition of the plant, be partially or wholly filled with latex. When the cortex is incised the latex escapes, the quantity thus issuing depending largely upon the structural relations of the laticifers and the moisture conditions. A given incision allows the latex to issue only from a local area, dependent in extent upon the nature of the laticiferous system being tapped; generally several, and sometimes a very large number of, incisions may be made on the basal part of the stem.

Collecting Latex.

The latex is usually obtained by making incisions in the cortex of the living plant, and placing receptacles beneath each incision or groups of incisions; this method is in use in the extraction from tree forms, such as *Hevea*, *Castilloa*, and *Funtumia*, and also from some vines of the *Landolphia* type. When the plants are small (*Parthenium argentatum*), or when the latex is concentrated in the roots (*Landolphia Thollonii*), the latex is not usually extracted as such, but is allowed to dry within the plant tissues; the residual rubber is obtained therefrom by a process of steeping and softening the tissues in water or certain solutions, and subsequent maceration. A sample of *Landolphia* rubber thus prepared has been kindly sent by Mr. Johnston for your inspection.

In collecting the latex from living trees, several systems are in vogue. In some parts of Africa and America, the natives fell the trees, and after having placed the trunk in a proper position, ring it at definite intervals along the length of the stem; they then collect the latex issuing from each cut in a receptacle made of leaves or some other convenient or common article. The more intelligent natives make incisions in the basal part of the stem with a heavy hatchet, or large knife, and allow the trees to remain standing in order that at some subsequent date they may be again tapped. In some parts of Mexico the natives appear to believe more in the tapping of the higher parts of the Castilloa trees; an illustration showing a Mexican at work, is here reproduced. In some parts of Mexico, even skilled Europeans appear to have recourse to the use of large unwieldly knives with which a heavy blow may be inflicted. Apparently the methods adopted in the collecting of wild rubber are not always based on the preservation of the trees or vines, and even when the exploited forests are under skilled supervision the bark is often severely bruised and the cambium layer more or less destroyed in local areas; the object in both cases appears to be the extraction of as much latex as possible from each tree in a single day or with the minimum expenditure of labour.

Methods on Eastern Plantations.

On the other hand there can be no doubt that the rubber planters on Eastern estates, whose work is being closely followed and minutely imitated by visitors from many parts of the world, are striving to obtain satisfactory yields of latex by systems which allow the trees to remain in a healthy and vigorous state. The labour conditions prevailing in our Eastern possessions are such that very careful work can be cheaply done. The fact that each coolie is provided with paring and pricking knives and is capable of effectively tapping 40 to 200 trees as his daily task, is sufficient to indicate the shortness of the duration of the daily tapping operation on each tree. In the jungles possessing indigenous wild and scattered trees it is often impossible for the coolie to even walk the distance separating ten or twenty scattered rubber trees as a daily task; consequently, when a rubber tree is found the coolie does not lose sight of it until he has extracted the maximum amount of latex from it.

On Eastern plantations the objects are (1) to treat the trees very lightly each day; (2) to irritate only the first five or six feet from the base; (3 to avoid too rapid excision of the bark; and (4) to obtain the latex from the innermost and more abundant laticiferous channels without unduly damaging the cambium or healing layer of the stem.

Systems of Tapping.

The systems of tapping now in vogue are numerous; they include the V, single oblique, half-herring-bone, full herring-bone, inverted V, half-spiral, and full spiral systems. The lines in each system usually incline at an angle of 30 to 45 degrees, and are distanced approximately twelve inches apart. Most of these systems are planned out on several or four sides of each tree, and one part or side is tapped on successive days; the full spiral system is the only one which completely taps the whole of the cortex. When the tapping areas, on each of the four sides of a tree, are disposed so as to face north, south, east, and west, compass tapping is often adopted. On badly-tapped trees, or those with irregular gnarled surfaces, a zig-zag system is necessary in order to secure a gradual slope of each line between the knots. The V system was largely adopted in the early days, and is among one of the oldest known; the inverted V and the full spiral systems are the most recent; the half- or full herring-bone principle appears to be more frequently adopted than any other system. The full spiral system gives very large yields, but if tapping is carried on too rapidly it may endanger the health of the tree, and involve considerable waste of cortical tissues.

Frequency of Tapping.

The frequency of tapping operations is generally largely determined by the labour and supervision available, and as far as *Hevea brasiliensis* is concerned the greatest fear is, that when once the large acreages are in bearing there may be some difficulty in obtaining the labour necessary to take full advantage of the yielding capabilities of the trees.

The illustrations show the condition of the trees after they have been tapped every day, every alternate day, twice per week, once per week, once per month, and so on, for a period of eleven months. It is a curious fact that tapping every day may give lower yields than tapping every alternate day on account of the too rapid excision of the cortical tissues wherein the laticiferous channels develop day by day. The following are some of the results obtained up to the time of my departure from Ceylon, in January last, at the Henaratgoda Garden. There were five trees of *Hevea brasiliensis* in each group, and all were tapped on the full spiral system; the trees were alternately pared and pricked during the period under experiment, and were twenty-nine to thirty years old:—

Frequency of Tapping.	Number of times tapped.	Yield of dry rubber, per tree.	
		lb.	oz.
Every day	354	12	8
Every alternate day ..	177	14	3
Once per week	64	6	1
Once per month	15	0	12

The tapping operations were carried out during ordinary working days, excepting Sundays and times of flood, etc., in order to make the results applicable, as far as possible, to the conditions obtaining on the average rubber estate. The tapping of the trees in the first two groups—every day and every alternate day—was suspended for a short period, but the trees in the other groups were tapped for fifteen months. These results should only be viewed in a very general manner, but the danger of too frequent tapping is manifest from the above series.

The frequency of tapping should theoretically be determined by the wound response and ease of the flow of latex, but practically a system must be devised which, while it may involve a little waste of cortical tissue, will allow one to regularly employ the labour on estates, and thus obviate a greater waste of money or general disorganization. Though the proprietors of several rubber plantations are fully aware of the value of periodicity in tapping, they are compelled to adopt methods absolutely opposed to all plant requirements, and some anticipate only being able to tap sections of their properties in successive years, instead of each tree every alternate day.

Frequency and Response.

Regarding this subject of frequency or periodicity in tapping it is interesting to recall the results of certain experiments with *Hevea brasiliensis* and *Manihot Glaziovii*. When *Hevea brasiliensis* is first tapped the flow of latex is often insignificant, but on re-tapping in approximately the same area it is noticed that the yield of latex gradually increases until the maximum is reached. This was, as far as my knowledge goes, first clearly determined by Parkin, in Ceylon, and has been since confirmed in Java by Dr. Tromp de Haas, and by Mr. Stanley Arden, in the Federated Malay States. This wound response in *Hevea brasiliensis* is explainable if we imagine that repetitional tapping or irritation in the same area leads to a distended condition of the latex tubes which, being in communication with neighbouring channels of the laticiferous system, become charged to their maximum extent and consequently give a higher latex yield. The wound response is obvious after 24 hours, and may become more pronounced day by day until the maximum may, according to Parkin, be reached on the 14th day. When the laticiferous channels have been drained of their contents an interval of time must elapse before they can be expected to yield the largest quantities of latex. The same experiments have been made with some twenty-year-old trees of *Manihot Glaziovii*, but have not been accompanied by the same results.

Coagulation.

The latex obtained from the plants is rarely exported as such; it is usually subjected to some treatment which ensures the removal of the greater part of the water. The methods employed in different parts of the world show a great variance, and are often founded on opposing principles. Most of the processes in vogue at the present time involve chemical changes of certain original constituents of the latex, a few enable the operator to separate the caoutchouc by mechanical means—in which cases chemical changes are either entirely stopped or only allowed to continue for a short time.

The fresh latices may be neutral, acid, or alkaline in reaction; they consist essentially of a liquid in which caoutchouc and other globules are held in suspension, and other substances in solution. When latex has been coagulated, the caoutchouc globules form an irregular but connected network enclosing certain resinous and albuminous matter; by the contraction of the caoutchouc the water with some of its dissolved substances is expelled.

Coagulation often takes place as soon as the latex is exposed to air; other latices will remain much in the original condition for several days.

Latices, which are liable to undergo putrefactive changes on exposure to air, may sometimes be prevented from coagulating by the addition of formal, which prevents decomposition, or by the addition of ammonia which neutralizes the acids as soon as they are produced. In the simplest cases, coagulation is effected by allowing the latex to stand in circular or rectangular receptacles until decomposition sets in and a strong acidity is developed; sometimes the caoutchouc globules, owing to their being lighter than water, can be separated from the other constituents by centrifugal machines; the addition of water alone, or of aqueous solutions of heavy sodium salts, is often sufficient to cause the light globules of caoutchouc to rise to the surface. Some latices can be coagulated by boiling, or by the application of heat. In many cases, however, the latices are treated with chemical re-agents of an acid, alkaline, or alcoholic nature, or with acid and alkaline plant juices. The Amazon method of preparing fine hard Para rubber from the latex of *Hevea brasiliensis*, partly depends for its success on each thin particle of rubber being impregnated with small quantities of acetic acid and creosote. On plantations of *Hevea brasiliensis* small quantities of acetic acid are used to hasten coagulation, and the use of coagulating re-agents possessing antiseptic properties is also receiving much attention in the East.

It is impossible in one paper to give the details of the operations which are being carried out in the preparation of rubber from latex in all parts of the tropics. This has been dealt with elsewhere.* It is sufficient to know that the latex can usually be rapidly converted into rubber ready for export.

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* See "*Hevea brasiliensis:* its botany, cultivation, chemistry, and diseases;" Messrs. A. M. and J. Ferguson, Colombo, 1906.

Most of the wild rubber arrives in Europe in a very wet state, but that from plantations is usually nearly dry; the former condition leads to a wavering in the price of the raw material, since the water contents are liable to great variation. The wild rubber, as you can see by the specimens on exhibition to-day, arrives in many forms, but that from plantations in the East is usually in the form of crêpe, sheet, block or biscuit, and of a high standard of purity.

Yields.

The yield of rubber obtainable from the different species under cultivation is a subject about which much has been said: it is on this factor that the success of the rubber industry rests. It is perhaps too early to make any definite statements, especially with reference to the yield obtainable from wild trees and vines of doubtful age, and growing under conditions the significance of which is but little understood. An annual yield of one pound of dry rubber per tree is, perhaps, above the average for plantation trees of *Manihot* and *Castilloa;* a yield of two pounds per tree has been reported for trees of *Funtumia elastica* in the wild state, and annual yields of a few ounces, per vine, for certain wild *Landolphia* plants have been estimated. We have, fortunately, some information regarding the yields obtainable from trees of *Hevea brasiliensis* on Eastern plantations. Generally, the maximum yields of rubber are obtained during the first series of tappings; subsequent tappings may give poorer yields, though each tapping operation involves an equal excision of the bark. It will be quite obvious that the very best results with the minimum waste of cortex and of labour will be accomplished by taking full advantage of what may, perhaps, be termed the replenishing periodicity of the laticiferous channels. The results show that to tap too frequently may not only lead to a great waste of money in labour expenditure, but actually to a reduction in the total amount of rubber obtainable from the tapped trees; they further show that by tapping at certain intervals and allowing certain periods of rest very large quantities of latex with very little expenditure of cortex or coolie labour, may be obtained. The best periodicities have not yet been determined, but sufficient has been said to indicate that such exist and deserve every consideration; all that can be said at present is (1) it may be dangerous to tap every day throughout the year; (2) tapping on alternate days throughout the year may give higher total yields per tree than tapping every day; (3) tapping the same area from three to 14 days in succession, in the case of *Hevea brasiliensis*, considerably depletes the laticiferous system; (4) tapping the same area daily for two or three weeks in succession partially depletes the laticiferous system of *Manihot Glaziovii*, and a rest must be given or fresh areas tapped. The results at present available indicate how valuable economic botanical investigations in the tropics may be to cultivators, and though it may not be commercially possible to exactly conduct operations which appear to be desirable from the purely scientific standpoint, yet I feel sure that the principles will ultimately, either partially or wholly, become an integral part of the daily operations on the best conducted plantations.

Future Yields from Renewed Cortex.

The yields with which we have previously dealt, and on which the hopes of the future have been largely based, have been obtained by tapping the original cortex; success in the future depends, however, on the yields obtainable from the renewed bark. In the more modern and systematic methods of tapping it is customary to repeatedly pare the lower surface of each sloping cut until nearly the whole of the original cortex has been excised. The innermost part of the cortex and the cambium are not intentionally excised; the cambium layer, by the division of its cells, gradually produces new cortical tissue from within, outwards; sometimes when the cambium has been severely damaged, new cortical tissue is produced from above, downwards, in a conspicuous manner, and the addition of new cells from within, outwards, only occurs when the injured region has been completely repaired. On some estates the cortical stripping round the whole of the tree has been effected in one year, and fair yields have been obtained from renewed cortical tissue which was only one year old. It has been demonstrated, however, that tapping young renewed bark is not always advisable; normal latex possesses about 50 to 60 per cent. of water, but that from renewed bark, only one year old, may under certain conditions possess as much as 90 per cent. of water and very little caoutchouc; furthermore, too frequent paring of the cortex will impair the vigour of the tree, and may result in early decay and death. At the present time the cortical tissues are removed at different rates, many planters cutting away the whole of the tissue between the parallel tapping lines, originally distanced twelve inches apart, in one year. It has been shown, however, that a tree may be pricked and pared on about ninety occasions in one year, and yet only three out of the twelve inches of bark between parallel cuts be removed.

Tapping at the rate of three inches per year, even on the full spiral system, a period of four years would elapse before the whole of the original cortex could be removed; this would allow a sufficiently long period for the new cortex to mature. If this is adopted a continuance of satisfactory yields may be expected; if it is not carried out, one can only expect a latex rich in water, and inferior, if not dead, trees.

Yields from Young and Old Trees.

The main factor on which the rubber industry depends is the yield of rubber obtainable, and the period over which it can be guaranteed. It is satisfactory to be able to state that the yields already obtained from Para trees varying in age from 4 to 30 years are such that the industry may be expected to be able to withstand a very serious reduction in the price paid for the raw material. The cultivated trees can be first tapped when they have a circumference of twenty inches a yard from the ground, and may be tapped more or less continuously for the rest of their lives. Young trees are known which in the first year of careful and light tapping have given 4 to 16 ounces of dry rubber; trees from six to thirteen years old have given 2 lb. of rubber in one year, others eight to fifteen years have given 3 lb. in one year, and some of the very oldest trees at Henaratgoda have yielded as much as 15 lb. of rubber in eleven months. Naturally, the yield varies according to the system of tapping adopted—whether by the V, spiral, or herring-bone, etc., or whether paring or paring and pricking are adopted; it also varies according to the age and vigour of the trees and the part of the stem tapped. Generally, only the first five or six feet from the base is tapped, but on several estates where labour is plentiful and a few old Para trees exist, the latex is collected from the base up to ten, fifteen, and twenty feet. In the year 1905, a certain 198,000 trees, varying in age from four to twenty years, but mainly six to nine years old, were tapped and gave 246,800 lb. of rubber, or over one lb. per tree per year. In 1906, from the figures already available, this return is likely to show a good increase. From these and other considerations an average annual yield ranging from one to three lb. of rubber from mature trees appears possible, providing the constitution of the plant is understood and tapping operations are carried out in a scientific manner.

The outturn per acre can, of course, be easily calculated, and a Table is here given showing the output according to the distance the trees are planted and the yield obtained:—

Distance.	Number of trees per acre.	¾-lb. per tree.	1-lb. per tree.	1½-lb. per tree.	2-lb. per tree.	3-lb. per tree.
(Feet.)		lb.	lb.	lb.	lb.	lb.
10 × 10	435	326	435	652	870	1,305
10 × 15	290	217	290	435	580	870
15 × 15	193	145	193	289	386	579
15 × 20	145	109	145	217	290	435
20 × 20	109	82	109	163	218	327
20 × 25	87	65	87	130	174	261
25 × 25	70	52	70	105	140	210

Exceptional Yields.

The reports of yields which have been obtained from trees of *Hevea brasiliensis* in Ceylon and the Federated Malay States have been discredited, especially by persons who have been tapping trees other than *Hevea*. In my opinion no records which I have seen have depicted impossible yields, and knowing from experience the yield of rubber obtainable per unit of excised bark by all the systems of tapping, and from various sections of the stem, I feel inclined to the hope that once we understand our plants, much better average yields may be obtained. The largest yield which I obtained in Ceylon was 15 lb. of rubber from one tree 29 to 30 years old, in 11 months; it was my belief, confirmed by a few score of men of experience who visited the tapped trees at Henaratgoda, that it would have been easily possible, at the sacrifice of the tree, to obtain three times the amount from the specimen in question.

Yield According to System.

It is necesary to point out that the yields procurable by the full spiral system represent those obtainable when the cortex around the whole of the stem is tapped; on the other hand, the yields for other systems usually represent those derived from a fraction or one side only of each tree, and are such that they may be expected to be more continuous over successive periods when the alternative sides are tapped in turn. On the herring-bone system, for instance, one out of four available sides may be tapped for one year and the other sides tapped in successive years. It is unnecessary to give the yields obtained by each system and per unit of excised bark, as these have been published elsewhere.

Latex from Different Sections.

Some laticiferous plants yield rubber of good quality when quite young, but this cannot be said of the *Hevea*, *Castilloa*, or *Manihot* species in Ceylon. The cortex of the seedling of *Hevea brasiliensis* and the cotyledons of the seed itself possess a large number of laticiferous channels, but the latex obtainable therefrom is usually very sticky and the dried product of low commercial value. Rubber prepared from two-year-old trees of *Hevea brasiliensis* is sticky and easily snaps when lightly stretched; that from four-year-old trees or from stems which have a circumference of about twenty inches, though it does not possess the properties which manufacturers most desire, realizes a price which is, to the producers, satisfactory. When a tree is tapped for the first time, though it may be 4 to 29 years old, the rubber obtained from the latex is apt to turn soft, sticky, or tacky on keeping; this is usually accounted for by the large proportion of sap contents which are unavoidably mixed with the latex when the original incisions are made, the sugars, gums, etc., from the cortical cells providing a good food supply for bacteria responsible for the development of tackiness in rubber. Subsequent tappings of trees of these dimensions usually give good rubber when the tapping operations are carried out on the basal part (base to 5 or 6 feet); it is curious, however, to note that when the higher parts of old trees are tapped the latex obtained is often changed in constitution. The latex from high parts is often very watery, and possesses a low percentage of caoutchouc; on treatment with the requisite quantity of acid, coagulation does not take place; even when allowed to stand for several days a curdled liquid only is obtained, the particles of which are not elastic and do not adhere to one another.

The number of times when non-coagulable latex has been obtained from various sections of the stems of 29-year-old trees is given below, and in considering them it should be remembered that the circumference of the stems at the highest points tapped was not less than 30 inches.

Height of Tapping Area	Number of times tapped.	Number of times when latex not coagulable.	Percent. of tappings giving non-coagulable latex.
Base to 5 or 6 feet	1,165	9	0·77
„ 6 to 16 feet	95	1	1·05
„ 10 to 20 feet	94	1	1·06
„ 20 to 30 feet	94	2	2·12
„ 30 feet ...	171	24	14·03
„ 50 feet ...	84	5	5·95

Labour and Yields on Small and Large Plantations.

Owing to the co-operation and courtesy of the planting community in Ceylon, South India, and Malaya, I have been able to collect a considerable number of figures showing the yields on small and large properties for a few years in succession, and am enabled to bring a few general conclusions before you to-day. The most important fact which I wish to mention is that the yields obtained from the same trees in successive years have shown a slight increase; this is especially true in those cases where the tapping operations have not led to too rapid excision of the cortex. But though this is correct for small and some large estates, and though certain small properties have shown a very large increase per tree, yet the yield per acre on some plantations possessing a very large number of mature trees has shown a reduction. The cause for this reduction is that a large acreage has been tapped whenever labour permitted; sometimes only sections of the estates have been tapped, and in such instances each tree has not received the attention which those on smaller properties have. Sound trees of *Hevea brasiliensis* will stand tapping every alternate day throughout the greater part of the year, and while several friends assure me they are able to do this at present, others are equally emphatic on being unable to adopt such frequent tapping.

Notes on the Illustrations.

DURING, and after, the lecture a series of interesting slides was shown to illustrate the points dealt with in the evening's discourse. Mr. Wright acknowledged his gratitude for the loan of lantern slides from Mr. Oliphant Devitt and Mr. Livingston, and also for permission to reproduce slides from prints kindly lent by Bartholomew and Co. ("Atlas of World's Commerce"), and Mr. Spemann, Berlin; and Messrs. H. F. Macmillan and Ivor Etherington of Ceylon, for numerous illustrations. The remarks made at the meeting have been supplemented with further notes, which may be of interest in connection with the slides shown.

SLIDE SHOWING DISTRIBUTION OF RUBBER AREAS.

Mr. Wright said that it was obvious from the map that the classification of the rubber-producing areas into the three great divisions was justified from the standpoint of convenience. In the Central American regions the areas of small production were British Honduras, Costa Rica, Panama, and Mexico; these were relatively insignificant when compared with the Amazon district of South America.

In South America the areas of small production were Venezuela, Guiana, Columbia, Ceara, Peru, Bahia, and Bolivia, and certain areas bordering the Amazon region; the Amazon valley showed up prominently as an area of large production.

The West Indian Islands, included in the tropical American region, did not stand out very prominently as centres of rubber production. It was pointed out that in Cuba, Haiti, Havana, etc., very little, if any, rubber was produced, and that Jamaica, the scattered Bahamas, and the islands from Montserrat to Trinidad, were of the most importance in the West Indian group.

Coming to tropical Africa, one could see that rubber production was more or less centralized in the equatorial belt; especially in the Congo State and the French Congo. On the West Coast of Africa the most northerly point of production was near Senegal, and passing through French Guinea, Sierra Leone, Liberia, the Ivory Coast, Gold Coast, Lagos, Cameroons, and Angola, areas of small production were obvious. Uganda, parts of German East Africa, Rhodesia, and Portuguese Africa were similarly responsible for small quantities of rubber. The most southernly points of rubber production in Africa extended from Natal to Inhambane, including Zululand; the areas of large production were in the Congo State and in Angola.

The map also showed the distribution of the areas of small production on the west and east coasts of Madagascar.

In the Asiatic region, Borneo, Sumatra, Java, and the Malay Peninsula appeared to be the most prominent, but the Celebes, British and German New Guinea, New Caledonia, Southern India, and Burma were also of some importance at the present time.

The most noticeable point concerning the distribution and importance of these rubber-producing areas was that in the small area represented by Ceylon and the Malay Peninsula, there had been planted a sufficient number of trees to ultimately supply as much rubber as was last year exported from the whole of Africa, even though the rubber areas in the latter extended from Senegal to Natal.

The northern points of Queensland and Australia, though well within the tropical zone, were conspicuous as areas where rubber production or the growing of rubber plants had not yet been accomplished.

FUNTUMIA, MANIHOT, AND FICUS.

The lecturer then dealt with slides showing living plants of *Funtumia elastica*, a tree form indigenous to Africa; *Ficus elastica* from the East, and a 15-year-old tree of *Manihot Glaziovii* growing in Ceylon.

The *Manihot*, or *Ceara*, rubber tree had been tapped; the outer dark and loose bark had been peeled away, and the exposed fresh, green, cortex tapped on the single oblique system. The lecturer was sorry to say that the results obtained by this method of tapping were not very encouraging; the total yields from 15-year-old trees of this species were not very large compared to those obtainable from trees of other species of the same age. He thought that *Manihot*, *Ficus*, and *Castilloa* rubber trees required an entirely different system of tapping, a subject on which he hoped to make some remarks later.

REARING SEEDLINGS.

The next three slides showed how the plants of Para rubber were propagated before being planted. In number one the seedlings were very closely planted in ordinary nurseries. This is the method generally adopted in all parts of the tropics where the plants are required for use on the spot. If conditions permit, the seeds are often placed in the soil direct, and there is then no necessity to subsequently transplant. In this case, however, where seedlings are raised in the nursery they are often allowed to grow until they are one or two years old. When planted they vary in height from 12 inches to 4 feet, and it is obvious that the system of planting seedlings or "stumps" thus obtained may, under certain conditions, be an advantage.

The second slide showed basket plants; the baskets vary in dimensions, but are generally 8 or 10 inches in length, with a diameter of about 6 inches. They are filled with finely-divided soil, and the seeds then placed one in each basket. By such a method living plants are obtained; these can be placed in the ground without any interruption to the root system. There are but few vacancies when this method has been properly carried out, as only those seedlings which show the best development are generally used. The writer has on many occasions strongly recommended the use of basket plants whenever possible, in preference to stumps. The cost of the baskets is not very great.

The third slide represented seedlings which had been sent from Ceylon to Samoa in Wardian cases; these cases were specially constructed in order to allow the seeds to germinate and the young plants to develop during transit. The original plants sent from Kew to India, Ceylon, and Singapore in 1876 were despatched in such cases. It is, perhaps, the only direct method of sending living rubber plants over long distances, and has much to commend it. If the seeds are carefully sun-dried they usually germinate in about ten to twelve days after being sown, and as many as 1,500 to 2,000 seeds may, if necessary, be packed in one case. Sufficient soil is provided to allow the young plants to grow to a considerable size. The outstanding advantage is, that living plants and not seeds of doubtful germinating capacity arrive at their destination, and even when the cases have to be sent on journeys which may last for over one month, fifty per cent. of living plants may usually be relied upon. Of course the packing of seeds in Wardian cases, and even in ordinary boxes, for transmission to distant countries, is one requiring considerable skill and experience. It is clear, however, that there is nothing to prevent any country in the world from receiving living caoutchouc plants, providing the authorities are prepared to go to the expense of using Wardian cases.

PLANTING OPERATIONS.

This slide represented a field ready for planting; the sticks had been positioned at definite distances, holes had been made at each point; after an interval of several weeks the holes had been refilled with the exposed soil. The illustration showed a coolie in the act of planting a young seedling, or stump, from the nursery; it was necessary, the lecturer explained, that pressure should be exerted on the soil by the coolies in order to ensure the roots gaining a firm hold. In parts of the Malay Peninsula where the climatic conditions are such as not to constitute a drought, or in parts of Ceylon and other countries during the wet season, the seedlings thus planted can be left to develop in their own way; where a drought is expected, or likely to occur, after immediate planting, it is customary to shade the soil around the plant for some time. Where rats, porcupines, pigs, and deer are troublesome, it is often necessary to place a circle of barbed wire round each plant to protect it from being eaten, or its roots from being damaged.

CASSAVA.

This slide gave one an idea of a practice which obtains on many large acreages in the Straits Settlements and the Federated Malay States. Here cassava, or manihoc, had been interplanted in rows between the lines of the rubber trees ; both the rubber and cassava were planted at approximately the same time, and the slide showed the growth of both after an interval of about one year. Cassava is often, especially where rich soils are available, a considerable source of income on rubber estates, and being a food product, is one which lends itself to native methods of cultivation. The shade formed by the foliage of the cassava plants is one which keeps the undergrowth in check, thus reducing the cost of weeding on estates. It is, however, a very exhausting catch crop ; from the time of planting to the time of harvest an interval of about eighteen months is required, and it is doubtful whether it is in the interests of the estate to take more than one such crop off land planted with rubber. In other countries tobacco, citronella, lemon grass, bananas, and so forth, are grown with some amount of success, as catch crops on land planted with rubber. Catch crops under rubber, though in some circumstances they are to be recommended since they yield a profit, are often very dangerous, and in many cases have been grown to the detriment of the rubber plants.

TAPPING PARA RUBBER TREES.

In dealing with the next slides, the lecturer explained that rubber trees in Ceylon and Malay were tapped on the half-spiral, the full spiral, and full herring-bone systems. It was noticed that in most of them only the basal part of the stem was tapped, but in one case the trunk, from the base to a height of about 50 feet had been tapped on the full spiral system; such tapping gave very large yields of rubber, but the scaffolding necessary for such tall trees was very expensive, and Mr. Wright stated that the slide was more interesting as a curiosity than one indicating future methods of latex extraction.

The slides gave some idea of the small area of bark which had been removed during twelve months; in the herring-bone system the tapping operations could be carried out at the same rate for a period of six or more years before the whole cortex could be excised. Mr. Wright stated that he had repeatedly expressed his views on the subject of paring away the bark at a rapid rate at a time when it possessed reserve food supplies intended to be of use to the plant. He believed that in future our rubber trees in the East would be tapped much more carefully than they had been in the past; at the same time he pointed out that *Hevea brasiliensis* was a very hardy tree, and could only with difficulty be tapped to death. He had seen trees of Para rubber which had been killed by too frequent tapping, but such instances were seldom met with on well-managed properties.

It was pointed out on one slide that a receptacle was positioned at the top of the tapping areas; this was provided in order to supply drops of water at regular intervals along the cut surface. The drops of water carry away the latex to the can at the base of the tree, thus reducing the quantity of scrap rubber which usually coagulates along the tapping lines. The admission of large quantities of pure water does not seriously damage the latex or the rubber subsequently prepared from it; impure water should on no account be used.

Another point obvious from the slides was that weeding becomes unnecessary owing to the effective shade afforded by the trees of a Hevea plantation once they have attained the age of seven or more years. The great source of expenditure—weeding—comes to an end after five or seven years.

Another point of interest to those who have only dealt with rubber plants in wild areas, is the possibility of economically carrying out planting and collecting operations on such a property. All the coolies can be seen at work on the individual trees along every line, and the day's labour is capable of being almost minutely inspected by the superintendents in charge.

COAGULATING THE LATEX.

Two slides gave an idea of the condition in which the latex arrives at the factory, before being converted into wet rubber; on some estates the latex is brought to the factory in large receptacles, being carried on the heads of the coolies. On others, however, it is transmitted from one part of the estate to another in large milk cans, these being placed on a trolley and run along a mono-rail to the factory. The latex on arrival may be converted into rubber by the addition of a little acetic acid, formic acid, the juice of lime fruits, etc. It is poured into small circular or rectangular receptacles, or in large tilting casks. When the washing operation is not carried out the rubber from the small tins is in the form of circular biscuits, or rectangular sheets; when, however, large quantities of latex have to be dealt with, coagulation is effected *en bloc*, many gallons of the latex being treated with the requisite quantity of acid and allowed to stand overnight.

HANDLING OF THE RUBBER.

The freshly-coagulated rubber is generally passed through washing machines. The washing operation converts the spongy, irregular-shaped rubber into long strings of crêpe, which can be then dried, either in hot air chambers, or vacuum dryers. A specimen vacuum dryer was shown. Mr. Wright was indebted to Mr. Livingston for the information regarding the Passburg vacuum dryer shown.

The following is an extract from a communication received from Mr. Livingston :—

"The time that the rubber remains in the chamber is from 1¼ to 1¾ hours. The steam supply is shut off about a quarter of an hour before the rubber is dried, the heat in the metal of the chamber completing the last stage of the drying."

"When the vacuum is about 28½ inches, which is very usual, the temperature of the rubber remains at about 90° F., until the greater part of the mixture has been removed; it then slowly rises, and is taken out when the temperature reaches about 120° F."

"From letters I have had from Malay I understand they are using a very low steam pressure in the shelves, from 1 to 4 lb. only; they leave the rubber in the vacuum drier for 1½ to 2 hours. When they desire more output from a chamber they may increase the steam pressure, and shorten the drying time."

"The chamber, No. 7, which the lantern slide illustrates, receives about 330 lb. at a time of wet rubber, and in the rubber factories deals with about 30 cwt. of wet rubber per 24 hours."

BLOCKING OF RUBBER.

Sometimes, in order to prevent decomposition of certain constituents of the rubber, antiseptic re-agents are used, or the freshly-coagulated rubber is smoked; this does not, however, affect the condition of the *crêpe* as it leaves the curing-house, or vacuum dryer; it is usually then relatively soft, and can be cut up into sections, and placed in a press, and converted into blocks of different sizes.

The next illustration showed a photograph of the machinery used for blocking rubber; there was also a sample of the block rubber prepared on Lanadron estate, for inspection.

SLIDE SHOWING RUBBER FACTORY.

This slide represented an up-to-date plan of a plantation rubber factory and machinery, designed and manufactured by Brown and Davidson, Ceylon, and said to be in operation on several estates in the Federated Malay States, Ceylon, and Mexico. At one end of the building were the engines to supply the power required for the machinery, at the entrance were settling tanks wherein the latex could be accumulated and coagulated; these were capable of being tilted over, the freshly-coagulated material thereby being thrown on to a clean, washed floor. The rubber was then cut up into small pieces, passed through the rough and fine crêpe washing machines, and placed on the drip racks for the superfluous matter to escape. Alongside the drip racks were placed the vacuum dryers, and near these were the block presses. Separate spaces were provided for the washing and cleaning of collecting cups, pails, etc., hot and cold water being available, according to requirements. The stores, office, general working and packing space were at the opposite end of the building, the arrangement being one of convenience to the planter in the tropics.

DISCUSSION.

MANIHOT.

AT the conclusion of the lecture, which was well received, a very interesting discussion took place. The CHAIRMAN (Lt.-Col. Prain) heartily congratulated Mr. Wright on his instructive and comprehensive lecture, to which, he said, he had listened with a great deal of interest. He thought there was little to be said regarding the Manihot mentioned by Mr. Wright as cultivated in South America, which was not the same as Ceara rubber. It seemed to be well known in Saô Paulo, Southern Brazil, far to the south of Ceara, but it was not there considered to be the same as the Ceara rubber tree. Seeds of the same Manihot had been sent from Bahia, midway between Ceara and Saô Paulo. When sent from Bahia the seeds were termed Maniçoba, a name which was usually associated with the Ceara rubber tree *Manihot Glaziovii*. The use of the name Maniçoba at Bahia for that *Manihot* might mean that the seeds were termed Maniçoba, a name which was usually associated with the Ceara rubber tree *Manihot Glaziovii*. The use of the name Maniçoba at Bahia for that *Manihot* might mean that it was there thought to be the Ceara rubber tree. But it certainly was not *Manihot Glaziovii*, and it might be that in these two different Brazilian States the same name was applied indiscriminately to two different trees. The botanical name of that species was not yet known; nor was it known how its rubber compared with that of *Manihot Glaziovii*.

TROPICAL DISEASES.

Those who recalled what happened in Ceylon, when the leaf-disease attacked coffee, would ask whether rubber was necessarily exempt from the dangers to which other exotic crops were liable. People were more alive now to such possibilities than they were a generation ago; and it was now more generally recognised that what was spent in securing the services of good plant-pathologists was a sound form of insurance against such risks. Planters were now prepared to act, and act promptly, on lines laid down by competent advisers, should such a visitation occur. But in spite of all that was known and could be done there was even yet no absolute guarantee against sudden and overwhelming calamity. With regard to rubber such a visitation was not inevitable; considering the precautions that planters now took, it was perhaps unlikely. But it was not impossible. It had quite recently been reported that the cultivation of one particular rubber in Ceylon was impossible, owing to its liability to attack by an insect pest.

SYNTHETIC RUBBER.

Those who knew what had occurred in India since synthetic indigo first appeared into the market would equally ask whether rubber was necessarily safe against a like experience. The misgivings of some took the form of warm protests when the possibility was hinted at by their chemical brethren. It was not a foregone conclusion that chemistry would succeed in preparing artificial rubber on a commercial scale, nor was it certain that if synthetic rubber became an article of commerce natural rubber would cease to be required. But it was known that artificial rubber had actually been produced, and if the only instance of it so far recorded was in a sense accidental, one might be assured that chemistry would not rest content until that experience had been repeated, systematised, and, if possible, elaborated for commercial purposes.

LARGE PRODUCTION.

There was another risk which would be in the minds of all who were conversant with the story of cinchona cultivation in South-eastern Asia. They might anticipate that if the extension of rubber cultivation continued as it had done for the last few years low prices and abundant production was not only possible but probable. The lecturer had said that the change would be of much benefit to the industry. He (the Chairman) was connected for a considerable period with the cinchono industry, and his connection with that industry had been somewhat peculiar, because he had to act simultaneously in the three-fold capacity of planter, bark purchaser, and quinine maker. The question of benefit owing to low prices and abundant production he thus came to learn at first hand, was one that depended largely upon the point of view. The difficulty was that most movements were progressive, and it was not always easy to draw the line between abundant and superabundant production. There was, perhaps, less difficulty in drawing the line between prices that were not and prices that were too low. When that line required to be drawn, the producer had seriously to consider if it was worth his while to go on. That was a contingency which he thought had to be kept in mind, and, in time, to be faced.

ORGANISATION.

MR. R. K. GRAY said he had listened with a great deal of pleasure to the short *resumé* of the lecture by Mr. Wright, and he certainly had touched upon a subject which was of very great importance to many people in this country, but he felt in the same mind as the Chairman, that it was necessary to give a warning in connection with it. Although he himself was a manufacturer, and would like to see low prices, he did not like to see people get into too much of a fever when they had a good thing. He remembered some thirty or thirty-five years ago urging some friends of his in the East to go in for rubber planting, and he pointed out to them, what had been since proved to be correct, that rubber planting was not at all a question of planting trees merely, but of organisation. When tea and coffee planting failed to be remunerative, proper organisation was instituted, and it was certainly to the credit of tea and coffee growers that they should have started a new production which was conferring, and was going to confer in the future, a very great benefit on the rubber industry. It was a very different thing, however, where people went into a business with a good organisation as the stand-by, and where others went into it purely because there was some ground to be bought and plants to be planted. He desired to draw attention to the point, because he was very much interested in the rubber industry, and he would not like to occur in the rubber planting industry what had happened in other industries with disastrous effects leading to a discrediting of perfectly legitimate and profitable undertakings. Very excellent business was to be done in rubber estates, but when these had to be sold to an investing public, organisation as well as ground and plants should be included in the bargain. Manufacturers who had been in the rubber business for many years did not go into the rubber-growing industry, not because they did not believe in it, but because they thought it was more an affair for the Government than for private individuals. It was interesting to hear (and he thought it was to the credit of this country) of the large extension of rubber planting that had taken place in the East, because he thought that the extension had been very largely due to the Department at Kew. Some people—and he was amongst them—were wont to criticise Government Departments in this country for wasting money; some Departments were always being pitched into, and it was a great pleasure to him to be able to say that the extension of the rubber industry abroad was in a large measure due to the Department at Kew. Mr. Wright's lecture was so full, and contained such a great deal of information and instruction, and Mr. Wright was so great an authority on the subject, that it was hardly possible to criticise what he had said.

STABILITY OF THE INDUSTRY.

MR. FRITZ ZORN said he would like to re-echo the expressions of congratulation on the very interesting lecture by Mr. Wright. There was one point which had escaped notice, and this was that the Ceylon planters were very good sportsmen, and they had always shown themselves great sportsmen in the way in which they had taken up rubber cultivation, because it was to be remembered that comparatively few years ago the men who started planting rubber were looked upon as visionaries and laughed at. But now the laugh was all on their own side. He was very glad that a note of warning had been struck by the Chairman and the previous speaker, because it was very necessary. At the present time some of the older rubber companies were showing the first fruits of their enterprise, two of the most mature companies having recently announced dividends for the year of 40 per cent.; but there was the danger that, with such large profits being shown, companies of a very different description might be placed before the investing public, and thus bring into disrepute an industry which ought to be a great one for those engaged in it. He thought it would also be of value if the lecturer could state whether considerable danger might exist from the possible disease of the rubber plant. The question of the production of artificial rubber was one which might be easily exaggerated. Synthetic rubber must be produced at a price which would enable it to compete with plantation rubber, and he believed he was correct in saying that the latter, as it was grown now, or would be grown in the course of a few years, could be produced at a cost roughly of 1s. a lb., so that unless artificial rubber could be made at a less price, the planter had nothing to fear. Another most important point was that, even if a completely satisfactory artificial rubber were made by chemists to-morrow, it would take a number of years to ascertain whether it possessed that most necessary quality of natural rubber, namely, durability. The archway under Euston Station was paved 18 years ago with a rubber composition, and during that time it had only worn to the small extent of five-eighths of an inch. It had been clearly demonstrated that, compared with wood, asphalte, and pavings of that description, rubber worked out much cheaper in the long run because of its enormous durability. If artificial rubber was produced, it would not be possible to demonstrate for many years whether it was durable, and they would in this case have to wait at least 18 years before they could test the respective qualities of the two, so that it would, therefore, even if successful, only very slowly displace the natural article. The parallel employed by the

Chairman with regard to cinchona and the fall in price was scarcely typical of rubber, for the reason that the latter was now standing at a remarkably high price compared with a few years ago; and if the price should fall from its present figure of 5s. to 4s. or 3s. 9d., there were many purposes for which rubber would be immediately employed for which, at its present price, it was far too expensive. If, on the other hand, cinchona bark were to fall very heavily in price, there were not many purposes for which it could be employed other than those for which it was already used; whereas, if the price of rubber fell, it could be used for road paving and numbers of things of that description. He knew that one leading manufacturer in the Midlands estimated that if rubber were to fall to 4s. a pound, the present consumption of about 65,000 tons per annum would be doubled, and if it fell to 3s. a pound it would be quadrupled. Those figures indicated that plantation rubber grown at a cost of 1s. a pound had not much to fear from over-production for many years to come.

PLANTATION RUBBER.

MR. S. FIGGIS, the well-known rubber broker, of the firm of S. Figgis and Co., said he had not intended intervening in the discussion, but he felt he could not agree with the statement of the last speaker that if the price of rubber fell to 4s. a lb. a great enlargement of consumption would be likely to take place. He wished he had the manufacturer in the Midlands, to which the last speaker had referred, as his customer, because it was not 20 years since he sold rubber at considerably less than half its present price. No such enlargement of the industry as had been suggested took place, although he was aware that the circumstances had now changed. He had sold the first imports of plantation rubber, and for years had encouraged its cultivation. As an old broker, who had sold rubber for nearly half a century, he had watched the development of the industry. He remembered almost the beginning of the Amazon supply, when the crop was about 500 tons, and now it had reached 38,500 tons. The consumption had kept pace with the increase in supply; but the lecturer was candid enough to say that, looking forward to the future, they must as sensible men expect a very large increase from the 250,000 acres in Malaya, India, and other regions where plantations were being made. He therefore thought it would be wise to bear in mind the warning which had been uttered, and not be too sanguine that the present prices would always continue. It would be within the recollection of many that cinchona once sold at 4s. a lb., and it had now come down to a penny and twopence simply because of over-production. He therefore thought the words of caution which he understood Mr. Gray to suggest were wise, and from his experience he hardly expected the very great development in new uses of rubber, referred to by the previous speaker. He had been very much struck with the admirable quality of the rubber at present shipped from Ceylon and other places, and did not think it could, as a whole, be easily excelled. Very few parcels of biscuits or sheet had come over at all soft or sticky, and it was a marvellous thing to him that the planters in such a new industry were now able to send to this country such splendid specimens of pure, useful rubber.

MARKET REQUIREMENTS.

The lecturer had suggested that planters would like to know how the manufacturers desired the rubber to be prepared, but personally he ventured to think planters would do well to remember that different manufacturers had different wants, and that it was undesirable to prepare the rubber in one uniform way. But as to the best method of preparing the rubber, perhaps Mr. Gray would be better able to tell them that, as it was trade business, but from his enquiries he had ventured to make certain suggestions in the annual review he had issued for many years. After a long and wide experience of rubber from all parts of the world, and having sold more rubber as a broker than probably any man living, he desired to say that the planters deserved the utmost praise for the way in which they prepared their product, and the beautiful way in which it was packed and sent to this country; and they were also thankful to Kew and the Colonial Office to a large extent, because it was owing to their efforts that the wonderful success which had been achieved by the industry was due.

RUBBER AND CACAO.

MR. HAMEL SMITH (Editor of "Tropical Life") remarked that in the West Indies it was found that the cacao estates, after about 25 years, were already beginning to fall off in their yield; but it seemed to him that if, as some people suggested, Castilloa was planted as a shade to cacao that falling away would take place at an even more rapid rate than it was doing where cacao was planted alone. He had been informed by a cacao planter that the output of cacao would fall away owing to the exhaustion of the soil. It seemed to him that if rubber were planted with cacao, the advantage would be gained on the crop from the rubber tree as a shade tree; but if it tended to deteriorate and hasten the falling off in the cacao crop,
rubber tree as a shade tree; but if it tended to deteriorate and hasten the falling off in the crop,

he thought the profit would in the long run be diminished rather than increased. He also desired to ask the author's opinion of the use of centrifugal force for separating the latex, as opinion on the subject seemed to be divided. If the latex were produced in such very large quantities as seemed probable, it seemed to him that an accelerated system of separation would have to be employed; and from his knowledge of the use of centrifugal apparatus on sugar estates, he thought that might be a useful method.

WILD AND PLANTATION RUBBER.

MR. WALTER HANCOCK remarked that, having devoted sixty years of his life to the manufacture of india-rubber and gutta-percha, he had been intensely interested in Mr. Wright's valuable paper, because it gave to manufacturers a great deal of information in a small compass. It might be in the recollection of some of the older members of the Society that forty years ago, when the question of india-rubber and gutta-percha was under discussion, he (Mr. Hancock) expressed his surprise that, considering the price india-rubber and gutta-percha fetched in the market, no one had taken the trouble to cultivate them. Leaving out of consideration the rare metals, silk and india-rubber were two of the most valuable articles imported into the country; they were articles which grew of themselves, required little cultivation, and after five or seven years produced a very handsome return upon the outlay devoted to them. He had been particularly struck with the quality of the rubber now imported from Malaya.

PURITY OF PLANTATION RUBBER.

One of the advantages he held out, when the matter was under discussion forty years ago, was that if the industry were placed in the hands of business men with a manufacturing turn of mind, it would be possible to obtain in this country india-rubber or gutta-percha free from the great defects of which the crude article then usually imported was so full. It was then full of chips of the trees and an unfair admixture of adulterations, which sometimes increased the weight 10, 15, and 20 per cent., for which the manufacturer had to pay the full price of the pure material. The beautiful uniform quality of the finest rubber recently imported was a matter for much congratulation. A great quantity of African rubber first imported into this country sold at 4d., 5d., and 6d. a pound, but it was ruined in the collection and by exposure to light and heat, so that after a short time it perished in the way in which india-rubber did, not by drying, as gutta-percha perished, but by becoming a slimy mass which melted away. Owing to the care which was now taken, more particularly in the manufacture of Malayan rubber, in keeping the latex in a liquid state, not allowing it to be exposed to air, light, or heat, and the way in which it was afterwards manufactured, an almost pure india-rubber was obtained which deservedly fetched a high price, not only because it was clean and pure, but, being free from adulterations, a rubber was obtained which was more likely to be durable, and which did not contain in itself the elements of decay. There appeared to be, he was sorry to say, too much of a rush for promoters to issue the prospectuses of companies for the supply of rubber. Some of the old-standing companies which had a business organisation were able to carry on the manufacture profitably, sensibly, and advantageously; but in some cases the unfortunate shareholders would ultimately find they had lost all their money.

SYNTHETIC RUBBER AND GUTTA.

The question of the production of synthetical rubber had been referred to; but for the last 61 years there had been many similar threats made. He had many times experimented upon an article that would be equal to india-rubber and gutta-percha, and apparently for a time with success, but with the test of time it vanished. It either became dry and friable and rotted, or it became sticky like birdlime, and was utterly useless. He had very little fear indeed, within his time at any rate, of manufacturers being frightened by the production of a synthetical rubber. Even if it could be made, the question was how far it would be durable. Both india-rubber and gutta-percha possessed most remarkable qualities, two of the most important being their resistance to water and their insulating properties. He was afraid that synthetical rubbers or gutta-perchas would, in the course of time, by drying and decaying or by becoming sticky, be utterly useless and unfit to compare with natural india-rubber.

VULCANISATION.

DR. HENRY STEVENS said that the question of synthetic rubber had been raised, and as a chemist he would like to say that although Tilden had prepared a substance resembling rubber from isoprene, some time ago, his results had been called in question in recent years, and the most recent work by Harries, in Germany, pointed to rubber having a constitution which made its formation from isoprene improbable. With regard to the question of the quality of plantation rubber, there was an opinion abroad that it did not possess the nerve of the Amazonian or hard-cured Para; but, it seemed to him, that could only be satisfactorily settled by vulcanising tests being made with plantation rubbers on exactly the same lines as with wild rubbers. He had himself, in the course of the last few months, carried out vulcanisation experiments with plantation rubbers, and the results were very gratifying.

The question of the direct treatment of plantation rubber for mastication and mixing appeared to be of considerable importance. If the latex was properly coagulated and the resultant mass thoroughly washed and dried on the plantations before exporting, it would appear superfluous for the manufacturers in this country to go through the whole process a second time, especially when the rubber arrives in the excellent condition in which it is now being received from well equipped estates. This would save the manufacturer the softening in warm water, followed by the washing and drying operations, the latter being a particularly slow process, especially if the rubber is stored for the purpose of allowing it to regain the peculiar physical condition in which it yields the best results on vulcanisation.

It was, of course, open to question how far it was permissible to draw general conclusions as to the behaviour of caoutchouc under manufacturing conditions from experiments with small quantities carried out on a laboratory scale, but if the latter might be taken as a guide it should be possible to masticate and mix washed and dried plantation rubber without any preliminary treatment, save, perhaps, a very short sojourn in the drying rooms, to remove superficial moisture, and provided, also, the rubber was put up in a convenient form for treatment between the mixing rolls.

It would be of great interest to hear the views of manufacturers on this question.

Mr. Wright thanked the members for the manner in which they had received the paper, and said that with regard to the series of cautions which had been discussed, he forgot to mention one in connection with the tapping operations as carried out at the present time on a few estates in the tropics. Several planters appeared to be proud of the fact that they were able to manufacture their rubber, in large quantities, from shavings, *i.e.*, the bark which was peeled away every day, or whenever the tapping operation was performed, contained a certain amount of latex, which, on drying, could be extracted in the form of rubber. They were evidently anxious to show a very high return from the bark shavings; but it was possible so to tap the trees that the outer bark would dry, and possess not more than 1 per cent. of rubber. To extract 8, 10 per cent., and even more, of rubber from bark shavings, as had been stated in some reports recently issued, was, he thought, really more a disgrace than an honour. On some estates, where too rapid tapping had been carried out, fatal results were observable. He had made experiments in connection with the subject in Ceylon, and he knew in one or two cases that, although the original tappings might give latex possessing 40 to 50 per cent. of water, and up to 50 per cent. of caoutchouc, subsequent tappings of trees which had been too frequently irritated, gave latex in abundance, but one which might contain 90 per cent. of water, and only 10 per cent. of caoutchouc. That was a most important matter which ought to be brought before the planters. He did not believe at the present time, owing to the precautions which were being taken, that there was the slightest danger of any disease for a few years to come. Mr. Hamel Smith referred to the question of cacao and rubber. Personally, he was not very much in favour of *Castilloa* and cacao, and the only reports issued by the botanic department of St. Lucia and Dominica showed that much better results had been obtained when *Hevea brasiliensis* had been used in conjunction with cacao instead of *Castilloa.* He strongly recommended *Hevea brasiliensis.* Mr. Smith also mentioned that the cacao would sooner or later die. Cacao was a rather peculiar plant, the root system of the tree being quite unlike that of most other plants cultivated. It was not as compact as the root system of tea, coffee, or the coconut palm. The roots were widely separated and allowed of the penetration of the roots of other plants, and the two products —rubber and cacao—could grow for a considerable length of time. He had in mind one cacao and rubber plantation which was, he believed, 20 years old; the trees of *Hevea brasiliensis* varied from 7 to 11 years old, and both products were doing excellently to-day. Mr. Smith also raised a question on the subject of separating the latex by centrifugal means. Weber, Biffin, and a few others had reported successful experiments in connection with the latex of Castilloa, stating that when the latex of that species was subjected to centrifugal force in an ordinary creaming machine it was possible, owing to the large size of the caoutchouc globules, to separate them. He (Mr. Wright) thought he could do the same with Hevea; but on placing the ordinary latex of *Hevea brasiliensis* in a centrifugal machine, which was made to revolve at the rate of 11,000 feet per minute, there was no separation effected. The caoutchouc globules in *Hevea brasiliensis* were very small, and even if the density of the mother liquor was increased by the addition of solutions of sodium sulphate, it still seemed impossible to separate the globules of Hevea by mechanical means.

The following Samples of India-Rubber, collected by Messrs. Edward Till & Co., were Exhibited at the Meeting:—

No.		*Whence.*	*General Notes on Characters.*
1.	Lent by Edward Till and Co.	Africa.	Sierra Leone Red Niggers.
2.	,, ,, ...	,,	Assinee Niggers.
3.	,, ,, ...	,,	Manoh Twists.
4.	,, ,, ...	,,	Grand Bassam Cake.
5.	,, ,, ...	,,	Hansa Cake.
6.	,, ,, ...	,,	Ivory Coast Niggers.
7.	,, ,, ...	,,	Gambia Niggers.
8.	,, ,, ...	,,	Congo Ball.
9.	,, ,, ...	,,	Cameroon.
10.	,, ,, ...	,,	Benguela.
11.	,, ,, ...	,,	Grand Bassam Roots.
12.	,, ,, ...	,,	,, Niggers.
13.	Anglo-Malay Rubber Co., Ltd.	Straits.	Sheet.
14.	,, ,, ...	,,	Fine Pale Crêpe.
15.	,, ,, ...	,,	(1) Crêpe.
16.	,, ,, ...	,,	(2) ,,
17.	,, ,, ...	,,	(3) ,,
18.	Cicely Rubber Estate	,,	Sheet.
19.	,, ,, ...	,,	Crêpe.

No.		*Whence.*	*General Notes on Characters.*
20.	Batu Tiga Rubber Co., Ltd.	Straits.	Biscuits.
21.	Gikiyanakanda Rubber Estate	Ceylon.	Fine light worms.
22.	,, ,,	,,	Worms, block.
23.	,, ,,	,,	Biscuits.
24.	,, ,,	,,	(1) Crêpe.
25.	,, ,,	,,	(2) ,,
26.	,, ,,	,,	(3) ,,
27.	Kuala Lumpur Rubber Co., Ltd.	Straits.	Fine Pale Crêpe.
28.	Kepitigalla Rubber Estate	Ceylon.	Sheet.
29.	,, ,,	,,	Biscuits.
30.	,, ,,	,,	Virgin Block.
31.	Labu (F. M. S.) Rubber Co., Ltd.	Straits.	Sheet.
32.	,, ,, ,,	,,	Crêpe.
33.	Lanadron Rubber Estate	,,	Fine Block.
34.	North Borneo Trading Co., Ltd.	,,	Sheet.
35.	Pataling Rubber Estate Syndicate	,,	(1) Crêpe.
36.	,, ,,	,,	(2) ,,
37.	,, ,,	,,	(3) ,,
38.	K. M. A.	,,	Fine Sheet.
39.	,,	,,	Fine Block.
40.	Rubber Plantations, Ltd.	Ceylon.	Light Biscuits.
41.	,,	,,	Dark.

No.		*Whence.*	*General Notes on Characters.*
42.	Selangor Rubber Co., Ltd. (Sungei Rengan Estate)	Straits.	Sheet. (From $8\frac{1}{2}$ year old trees).
43.	,,	,,	No. 1 Crêpe.
44.	,,	,,	No. 1 ,, (Prepared with creosote.)
45.	,,	,,	No. 1 Scrap.
46.	,,	,,	Crêpe. (Prepared from Scrap collected off trees.)
47.	,,	,,	Crêpe. (Prepared from Bark shavings.)
48.	Heatherley Rubber Estate	Ceylon.	Biscuits.
49.	,, ,, ,,	,,	Crêpe.
50.	Yataderia Tea Co. of Ceylon	Ceylon.	Biscuits (Thin).
51.	,, ,,	,,	,, (Thick).
52.	,, ,,	,,	Scrap.
53.	,, ,,	,,	Block Scrap.
54.	Eastern Produce and Estates Co.	,,	Amber Biscuits (Thin).
55.	,, ,,	,,	,, (Thick).
56.	,, ,,	,,	Smoked Biscuits (Thin).
57.	,, ,,	,,	,, (Thick).
58.	,, ,,	,,	Scrap.
59.	,, ,,	,,	Block Scrap.

Exhibited by :—

Messrs. S. Figgis and Co. :—

Collection of samples of rubber as follows :

1. Fine Para Rubber.
2. Peruvian Ball Rubber.
3. Mattagrosso Virgin Rubber.
4. ,, Negroheads Rubber.
5. Uganda Plantation Sheet Rubber.
6. ,, Pears Rubber.
7. Sudan Ball and Sausage Rubber.
8. Congo "Cherries" Rubber.
9. Plantation Straits Sheet Rubber.
10. ,, Pale Crêpe Vallombrosa Rubber.
11. ,, Brown Crêpe Pressed Block Rubber.

Imperial Ethiopion Rubber Co.—

Sample of Vine Rubber from Abyssinia, supposed to be "Landolphia Kirkii."

Messrs. Lewis and Peat—

Samples of Plantation Rubber, in sheets, biscuits, crêpe, lace, &c., from Ceylon Estate.

Samples of Plantation Rubber from the West Indies, Assam, and Malaya.

Block of smoke-cured Biscuit Rubber from the Amazon.

Collection of Knives and Tools used in Rubber Industry.

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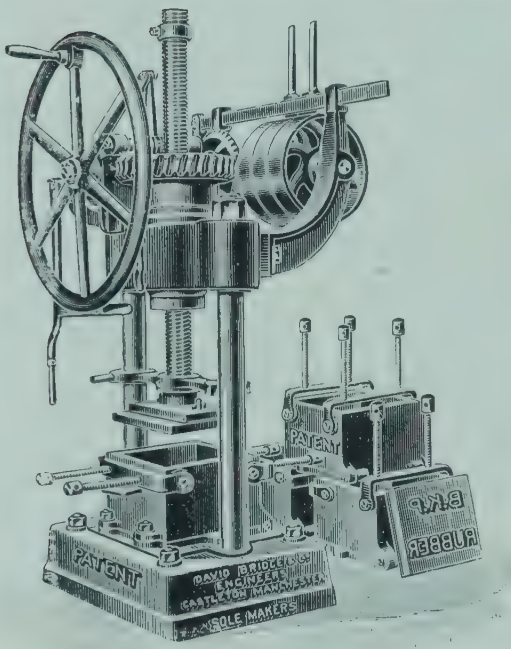

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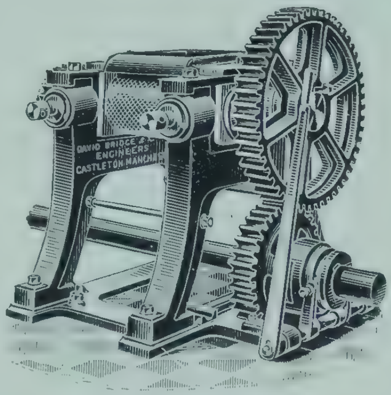

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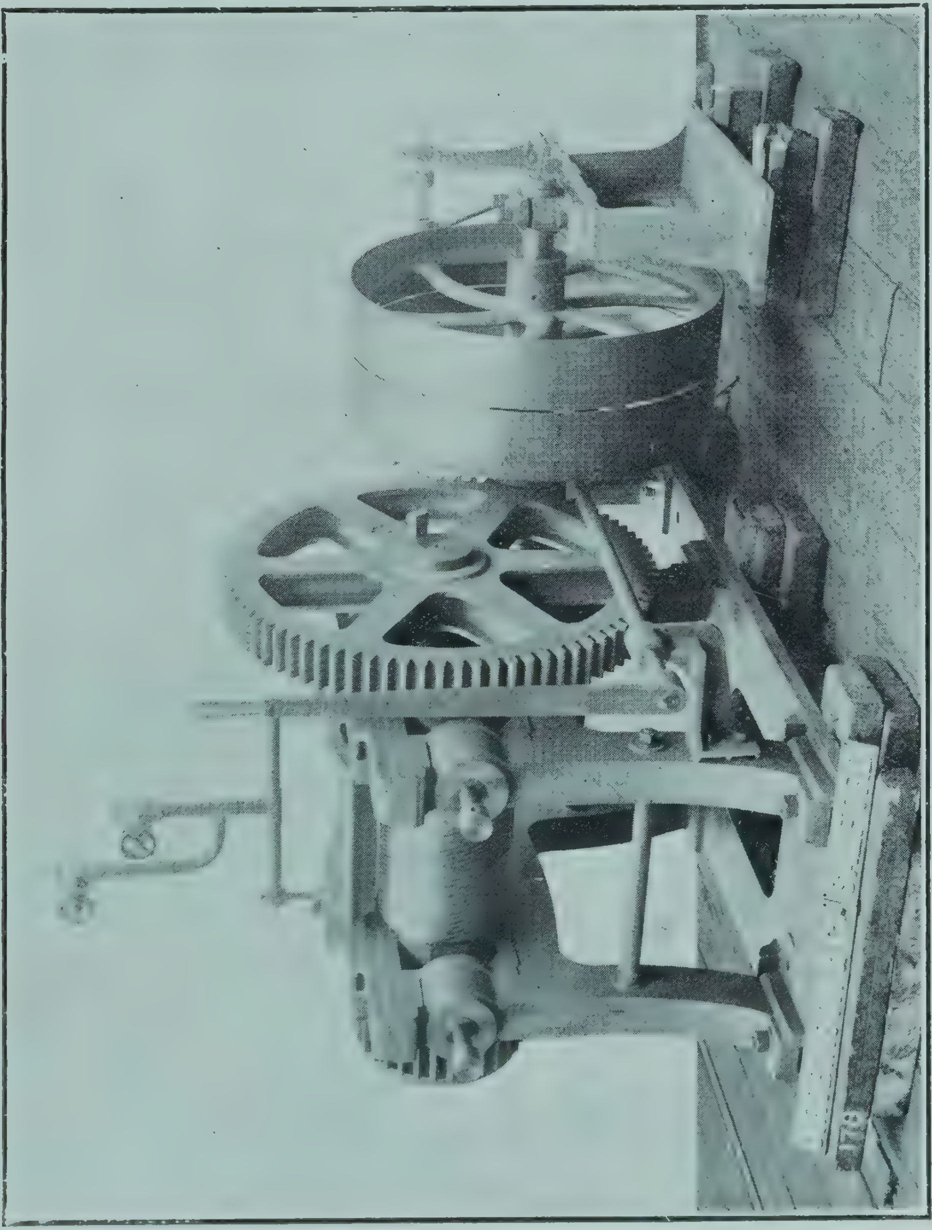

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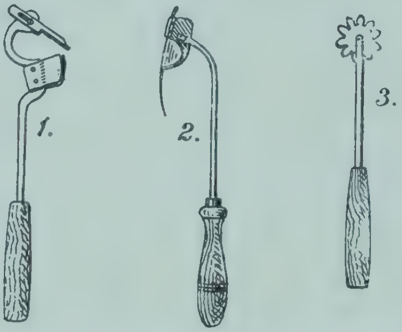

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